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ASIATIC CHOLERA

By

J. S. C. ELKINGTON, M.D., D.P.H.,

Chief Quarantine Officer-General,
North-Eastern Division.

ISSUED UNDER THE AUTHORITY OF THE
MINISTER FOR TRADE AND CUSTOMS

1916

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PREFACE.

This present volume on "Cholera" has been issued in pursuance of the policy of issuing for the information of quarantine officers and others interested a series of handbooks dealing with the various diseases likely to be encountered in quarantine work. Dr. Elkington has embodied in this volume both the results of his personal experience and an epitome of recent literature on the subject.

It has been thought advisable to include a transcript of the Report of the Sub-committee on Cholera to the International Sanitary Conference of 1912. The conclusions therein expressed are not entirely in accord with the results of research and experience which have been obtained since this Committee concluded its deliberations; but the report is valuable, inasmuch as it represents the result of careful study of the question in the light of knowledge available at that time, and as it forms the justification for the measures prescribed in respect of Cholera by the present International Sanitary Convention.

Subsequent knowledge, as epitomized in the Summary compiled by Dr. Elkington, must be held to be sufficient reason for differing from the conclusions expressed in the Sub-committee's Report and for departing, on occasion, from the provisions of the International Convention.

J. H. L. CUMPSTON, M.D., D.P.H.,
Director of Quarantine.

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ASIATIC CHOLERA.

1. HISTORICAL AND GEOGRAPHICAL ASPECTS OF CHOLERA.

In common with a few other countries, of which the number becomes less as time goes on, Australia has escaped, hitherto, the implantation of Asiatic Cholera. The disease has, indeed, been brought to our coasts, but some happy chance has served to protect us against an enemy whose spread on shore would have been much assisted by those defective methods of dealing with human exuviæ which yet permit enteric fever to persist in so many areas, urban and rural alike. The absence of a large native population, and of any considerable importation of native labourers from cholera-infected countries has certainly aided in securing this result.

The prospects of similar immunity in the future are, however, by no means reassuring. The history of cholera shows clearly its power of spreading along lines of human intercourse. Increasing speed and frequency of communication throughout the world, and especially along the great routes of commercial transit, bring with them a corresponding increase of risk in respect of the importation of epidemic disease to hitherto clean countries. Military operations have also brought about a mixture of races which has no parallel since the Crusades, and have put out of action the safeguards which operate under normal conditions to check spread in and from the endemic foci of South-eastern Europe and Asia Minor.

The continuation of the Hedjaz railway from Damascus to Mecca will ultimately increase very greatly the danger to Europe from this great clearing-house for cholera, and the development of Australian railways now authorized or under construction will link our chief centres of population more closely to infected areas in India, the Dutch Indies, and Asia. The following brief review of the world history of this disease will serve to illustrate its potentialities, and to indicate the growing risk to which Australia is exposed. Reference to the map on page 8, and to the tables printed in the Appendix, will make clear the gravity of the position.

Cholera seems to have been known in India from the most ancient times. Sanscrit writers in 400 B.C. describe symptoms resembling cholera. Susruta, writing in the seventh century A.D., described a disease attended by most of the classical signs and symptoms. It was recorded in 1438, mentioned by Vasco da Gama in 1490, described in Goa in 1543, in Pondicherry in 1768, in Calcutta in 1781–82, and in Burma in 1782–83. Some 66 separate observers mention the disease between 1438 and 1817 (1).

Cholera is also recorded as having occurred in Java in 1629 and in China in 1669 (1–2).

Between 1817 and 1823 cholera spread over the greater part of India, and overflowed into Arabia, Ceylon, Malacca, Singapore, Burma, Manila, Mauritius, and China. This is the first extensive outbreak recorded outside India. It was followed between 1826 and 1837 by a pandemic, which spread into Russia in 1829 by the great trade routes. From Western Russia the disease entered Poland, and thence involved Germany, Austria, Sweden, and England. France was infected in 1831, and in 1832–33 the whole of Europe was ravaged. Four thousand deaths occurred in London in 1832 and 7,000 in Paris. Ireland suffered a heavy mortality, and Canada and New York were infected by Irish immigrants fleeing from their stricken country. Cuba lost over 8,000 inhabitants out of a total of 65,000, and some 15,000 people died in Mexico. Very severe quarantine methods were employed in various countries, and Spain even inflicted the death penalty for infringement of regulations. These drastic measures failed completely to arrest the progress of the disease.

In 1848 cholera again reached Europe, *viâ* China, Burma, Afghanistan, and Orenburg. In 1849 Europe was widely infected in common with North America. The recorded cholera deaths in England during this outbreak numbered 53,293, and 119 separate localities were attacked.

From 1853 to 1857 cholera again invaded Europe, England, and America. In 1854 some 20,000 persons died in England, 140,000 in France, and 24,000 in Italy. Hamburg underwent a severe attack in 1857.

Cholera again reached Europe in 1865. In 1866 4,000 deaths from it occurred in London, and the disease again reached the United States and Canada. From 1870 to 1873 it was also present in Europe, having spread down the Vistula from Russia. North America was also infected.

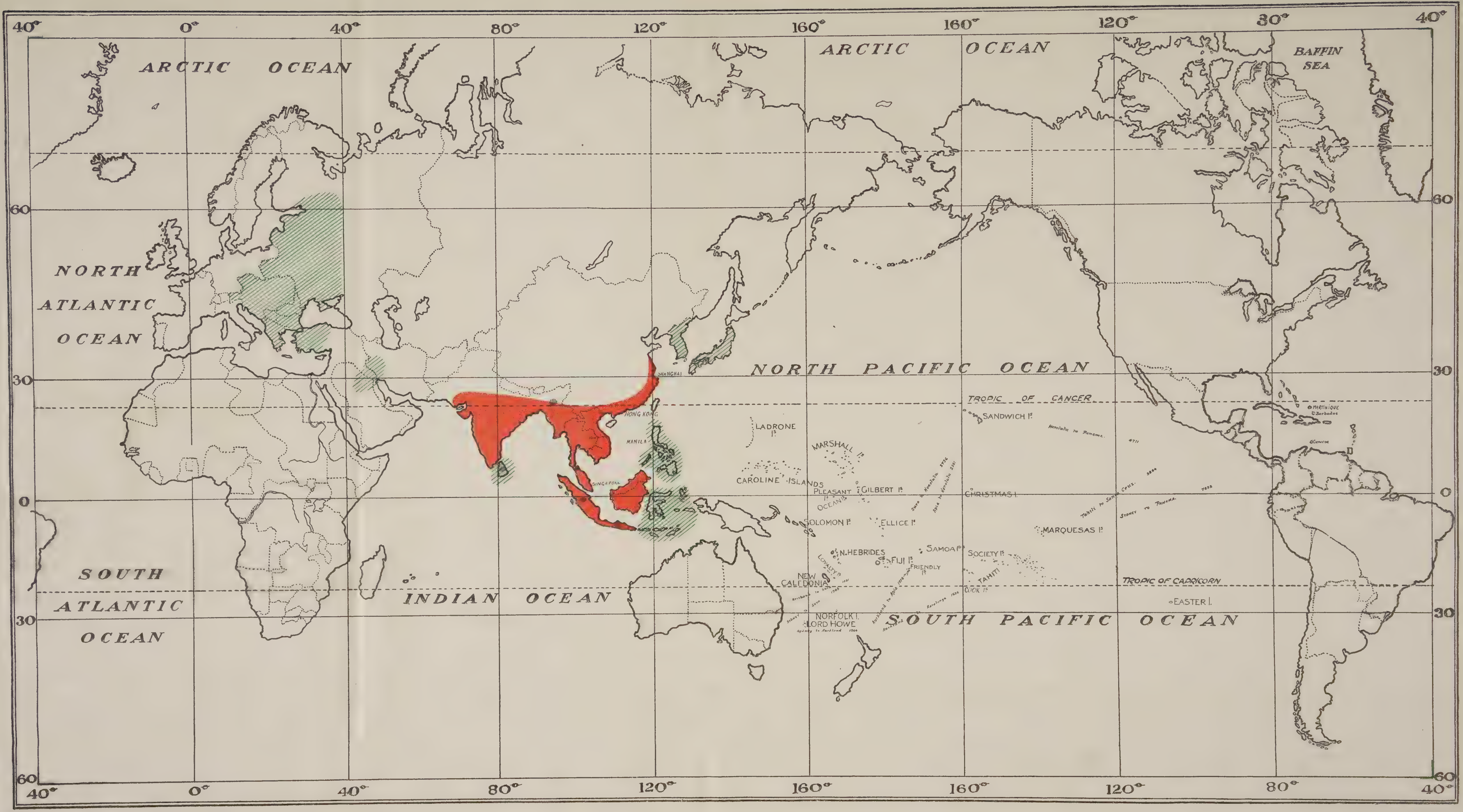
In 1884 and 1885 several ports in Southern France, Italy, and Spain were infected. Hamburg was once more infected in 1892, and Hull, Grimsby, and Yarmouth suffered in 1893 (3).

In 1900 there began in India a pandemic wave of cholera, which has continued to the present time. By 1902 it had spread to Egypt, Arabia, Syria, and Persia, and had involved Singapore, the Dutch Indies, China, Japan, Formosa, and the Philippine Islands. Asia Minor was reached in 1903, Russia and Turkey in Asia in 1904, Germany in 1905, Italy in 1910, and Roumania, Hungary, and Austria in 1911 (4). The countries returned as infected during 1914 include Ceylon, China, India, Burma, Java, Sumatra, Borneo, Celebes, French Indo-China, Japan, Persia, Siam, the Straits Settlements, Germany, Austria, Greece, Bulgaria, Serbia, Hungary, Russia, Turkey, and the Philippine Islands (5). The known European centres of infection in 1914 comprised 53 in Hungary, 39 in Austria, 10 in Germany 2 in Turkey, and 1 in Russia (6).

A striking feature of this great pandemic is the continued freedom of the United States from implanted infection, despite repeated arrivals of infected vessels from Italy and elsewhere. This illustrates the practical value of the extensive and well-directed prophylactic measures which have been applied both on the American seaboard and at Mediterranean ports with the co-operation of the Italian Government.

CHOLERA ON SHIPS.

During 1911 17 cases of cholera are recorded as having occurred on steamships lying in the port of Calcutta, and during 1912 11 other cases were reported on sea-going ships. In the port of Bombay 17 cases of cholera were notified amongst shipping in harbor. Cholera was conveyed on board several ships



Distribution of Cholera during years 1914-1915.

The green indicates the areas in which the disease was sporadic.

The red indicates the areas in which the disease was endemic.

at Shanghai in 1912, and was carried to various Japanese ports (7). The recent history of cholera in the Philippine Islands, Japan, Hawaii, Algeria, Tripoli, Greece, Malta, Spain, Austria, Bulgaria, Russia, and Egypt includes some striking instances of ship-borne infection (8), and the quarantine work at New York during 1911 necessitated dealing with a continuous succession of cholera-infected vessels for some four months, despite routine observational detention of immigrants before their departure from Naples (9).

CHOLERA ON AUSTRALIAN COAST.

Cholera is known to have reached Australian waters on at least one occasion (10). The s.s. *Dorunda*, an immigrant vessel, with some 290 passengers, sailed from London for Brisbane, *viâ* Malta, Port Said, Aden, and Batavia, in the latter part of 1885. Up to arrival at Tandjong Priok on 27th November no suspicious circumstances are noticeable in the medical history of the vessel. Cholera does not appear to have been specially prevalent in Batavia at the time, but it is admitted to have been endemic. Special precautions were taken to prevent communication with the shore by the immigrant passengers, and to keep off boats bringing fruit or foodstuffs. The only fruit taken aboard is stated to have been for the saloon passengers, none of whom suffered in the subsequent outbreak. It would appear, however, that some of the immigrant passengers succeeded in obtaining fruit surreptitiously from shore boats, and two ships' constables, who subsequently died, seem to have gone ashore for a brief period.

The vessel left Tandjong Priok for Thursday Island on 28th November. On the following day an elderly invalid amongst the immigrants reported sick with constipation and debility. On 2nd December he became somewhat seriously ill, and was isolated for some days, with a liberal use of disinfectants. His history, as given in the medical log, includes diarrhœa ("watery, but with colour"), cramps in the calves and feet, weak small pulse, diminution of urine, and vomiting. The isolation points to the fact that the case was regarded with suspicion, as perhaps does the note relating to the colour and consistency of his stools, but the diagnosis is given as "diarrhœa" or (later) "diarrhœa, malarial"; and at the subsequent inquiry the surgeon-superintendent expressed a definite opinion that this case was not one of cholera. The man recovered, but his attendant contracted cholera shortly afterwards.

A considerable number of cases of diarrhœa occurred amongst the immigrants about this time. On 6th December a child of eighteen months died after a brief acute illness, the cause of death being described as "convulsions from diarrhœa." The note against this case in the medical log runs as follows:—"Called to this child at 7.30 a.m., it had eaten meat last night for supper, and had consequently been suffering from diarrhœa all night; when seen it was in a state of collapse, pulseless at wrist; it died at 9 a.m." It is possibly significant that amongst the family to which this child belonged, another member was treated for "stomach" on 7th December, a second for choleraic diarrhœa on the 10th, a third for choleraic diarrhœa on the 12th (subsequently dying on the 13th), and a fourth for cholera on the 17th, with a fatal ending on the 22nd.

The *Dorunda* reached Thursday Island on 7th December, received pratique, and left the same day. The medical log records 6 new cases of diarrhœa on the 8th, and 2 of gastralgia. Cooktown was reached on the 9th. The surgeon superintendent reported a few cases of diarrhœa, and stated to the health officer that no infectious or contagious disease existed on board. The vessel again received pratique, and left for Townsville later in the same day.

On this day (9th December) a male immigrant passenger, 33 years of age, reported sick with diarrhœa and vomiting about 10 a.m. He grew worse all day, and died at 7.30 p.m., with well-marked symptoms of collapse. This was the first case logged as cholera. Later in the day two of this man's children developed the disease, and both died on the following day.

For the day of arrival at Townsville (10th December) the surgeon's log records 3 fresh cases of cholera, 6 of choleraic diarrhœa, and 14 of diarrhœa. Of the cholera cases, one was a hospital patient who had been under treatment since 8th December for "gastralgia." The health officer at Townsville held the vessel in quarantine, but permitted the burial of a body on Magnetic Island. The local quarantine station was not equipped for dealing with an emergency of such seriousness, and, after telegraphic communication with Brisbane, it was decided to send the vessel on to the better equipped establishment in Moreton Bay. Whilst at the Townsville anchorage on 11th December, 3 new cases of cholera were logged. Of these, 1 had been under treatment for malaria since the 8th; 1 for gastric pain, constipation, and severe vomiting since the 10th; and 1 for diarrhœa since the 9th. One case recorded as "gastralgia" (choleraic) had been admitted on the previous day for diarrhœa. Of 20 persons recorded as under treatment on this day (11th), all except 1 suffered from acute intestinal conditions.

The vessel left Townsville on 12th December. Sixteen cases of cholera, choleraic diarrhœa, or diarrhœa were reported on the 12th, 15 on the 13th, and 25 on the 14th. The Quarantine Station at Peel Island (Moreton Bay) was reached on the 15th, and the patients and passengers were landed in quarantine.

The last recorded case of cholera occurred on 17th December at Peel Island; but on the 20th some fifteen new cases of diarrhœa appear in the surgeon's log, with the additional note: "Several single women with diarrhœa, probably atmospheric." The medical log terminates on 7th January, 1886, and frequent references to cases of diarrhœa appear up to that date.

Seventeen persons in all are certified as having died of cholera. Four of these were children, from three to seven years of age. The cases logged as cholera numbered 20, and between 9th and 18th December the surgeon's log records some 14 cases of choleraic diarrhœa. It may be reasonably assumed that at least 50 cases of cholera occurred. The outbreak appears to have been limited entirely to the immigrant quarters. The following description of the disease by the surgeon superintendent of the vessel (Dr. Thomas Hickling) leaves no doubt as to its precise nature :—"The symptoms common to most of the patients were :—Painless diarrhœa, or in some cases severe pain without diarrhœa; vomit resembling dirty water; rice-water stools without smell; cramps in arms, thighs, legs, feet, and stomach; tongue and surface of the body cold; husky voice; suppression of urine; great thirst and restlessness; ashen or leaden hue of the face; cyanotic lips and nails; hands cold, clammy, and sodden; the fingers exhibiting rugæ of wrinkles like a washerwoman's; finally collapse, with absence of wrist-pulse. In cases which lingered there were the fever of reaction, which in some cases assumed a typhoid form" (10).

The principal features of epidemiological interest are:—

(1) The entry of infection to the vessel at Tandjong Priok, in spite of careful precautions against any form of shore-communication by the immigrant passengers, who alone suffered in the subsequent outbreak. The evidence at the subsequent inquiry appears to show, however, that some communication did occur, although to a slight degree only.

(2) The close limitation of the outbreak to the immigrant passengers. Neither saloon passengers nor crew were attacked.

(3) An evident tendency for cases to group in families and quarters.

(4) The long period (28th November to 9th December) between the apparent date of introduction of infection at Tandjong Priok and the occurrence of recognised acute cases.

(5) The apparent influence of missed cases in carrying on the infection during the voyage from Tandjong Priok to Cooktown.

(6) The apparent occurrence of several cases of cholera sicca, or at any rate of a delayed stage of evacuation.

OTHER AUSTRALIAN RECORDS OF CHOLERA.

A number of more or less vague references to alleged or suspected cases are scattered through various medical journals published in Australia from 1864 onwards, and in official reports on vital statistics; but the available evidence does not support any of these as having been true Asiatic cholera. That the risk of introduction of cholera was very clearly appreciated by Australian sanitarians of an early day is evident from an address to the Medical Society of Victoria, read by Dr. Dougan Bird, of Melbourne, in 1866, on "The Nature and Treatment of Epidemic Cholera." The *Australasian Medical Gazette* of 1898 refers to the existence of Asiatic cholera in British New Guinea, but the statement is not supported by the official reports of that dependency.

The writer, in 1912, heard, from natives of certain islands in Torres Straits, legends of a rapidly fatal disease which visited the islands in former days, and was attended by acute abdominal symptoms. The probability is that this was tropical dysentery.

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II. THE *SYMPTOMATOLOGY* AND CLINICAL DIAGNOSIS OF CHOLERA.

Sir Patrick Manson defines cholera as follows:—

> An acute infectious epidemic disease, characterized by profuse purging and vomiting of a colourless serous material, muscular cramps, suppression of urine, algidity and collapse, the presence of a special bacterium in the intestine and intestinal discharges, and a high mortality (1).

Whilst this furnishes an excellent clinical picture of the symptom—complex commonly met with in acute outbreaks of the ordinary virulent type—it fails to cover those mild or atypical cases which, if overlooked, may prove of great practical importance in spreading infection. For their detection expert bacteriological assistance is a scientific prerequisite. It is always necessary for any officer who may be called upon to handle an outbreak of cholera, or whose duties involve the protection of a community against the introduction of exotic disease, to have before his mind a clear picture of the clinical details, ascertained, observed, or even suspected, upon which a reasonable suspicion of cholera may be based, together with a vivid appreciation of the notable departures from the ordinary course which may occur in cases of cholera sicca, amongst young children, or in mild cases.

THE TYPICAL CASE.

An attack of cholera of the ordinary severe epidemic type may begin in either of two ways. It may come on suddenly without any well marked prodromal stage, or it may supervene more or less gradually in the course of what appears to be an ordinary attack of diarrhœa and gastric disturbance. In either case the clinical picture soon includes four salient features:—

(1) Profuse but painless diarrhœa, the stools rapidly becoming free from bile, fæcal appearance, and smell.

(2) Copious watery vomiting, with relatively little distress.

(3) Muscular cramps, usually working up from the extremities to the abdomen and lower part of the thorax, and increasing in intensity and frequency.

(4) Rapidly increasing prostration, with concomitant restlessness, weakening pulse at the wrist, cold clammy skin, and pinched, haggard face.

This, the *Stage of Copious Evacuation* (2), has as its predominant feature the loss of a large quantity of fluid in a short time. In a severe case the patient's body actually shrinks and shrivels before the observer's eye. The evacuations and vomit literally pour away, and several quarts of fluid may be passed in an hour or two. The surface temperature falls rapidly below normal, and usually presents a marked contrast with that in the rectum, the pulse becomes small and of very low tension, the heart beats increase in rapidity, and the patient complains of thirst. As soon as the loss of fluid has caused a marked fall in the blood pressure, there ensues—

(5) Diminution and eventual suppression of urine.

The differential diagnosis in this stage requires to be made from the following conditions :—

"English cholera," or cholera nostras.
Ptomaine poisoning.
Acute bacillary dysentery.
Algid malaria.
Acute arsenical poisoning.
Infantile diarrhœa.
Certain paratyphoid infections.

In all these conditions, except, possibly, the last, the stools commonly retain some tinge of yellow from the presence of bile, and more or less fæcal odour. In cholera, after the first emptying of the bowel and bile ducts the stools are opalescent and, generally, odourless. The opalescence of cholera stools is due to suspended epithelial flakes and granular matter from broken down cells, and on standing a portion of this suspended matter settles to the bottom. This is the classical "rice water" stool, so called from its resemblance to water in which rice has been boiled. If any colour is present, the stools are pink or reddish. They may have a faint "mawkish" odour, very different from the normal fæcal smell.

Complete suppression of urine is more frequent in cholera than in conditions simulating it.

In severe cholera nostras the clinical picture may resemble that of cholera very closely, and a bacteriological diagnosis will be required to make the differentiation with any certainty.

In ptomaine poisoning the evacuations are less copious than in cholera, and a history of simultaneous onset amongst a number of persons after the expiration of the cholera incubation period from leaving an infected port will indicate the advisability of making inquiries as to some common article of diet. The possibility of an unrecognised cholera case or a carrier on board will require, however, to be borne in mind. Recovery in ptomaine poisoning is more rapid than is the case with a severe attack of cholera. Bacteriological examination of the stools would probably clear up the diagnosis in any recent case.

Certain fungi may produce symptoms similar to those of cholera. The vomiting in such cases will probably precede the diarrhœa. Fragments of the fungus will be found in the vomit, and the history will point to the origin of the illness, especially if more than one person is affected. This condition is, of course, rarely encountered under any circumstances, and particularly so on board ship.

Acute bacillary dysentery is more likely to be confused with the stage of collapse in cholera. Careful examination of the fresh stools will show mucus and possibly blood. Bacteriological examination is necessary for conclusive diagnosis.

Algid malaria is more liable to be confused with cholera sicca than with the ordinary severe type of the disease although diarrhœa may be profuse. Microbiological examination of the blood and fæces will exclude cholera.

Acute irritant poisoning by arsenic or antimony may simulate cholera, but the complaint of metallic taste, the acuteness of the gastric symptoms, the severe and localized abdominal pain, and the character of the stools, will lead to suspicion of an irritant poison. Chemical analysis of the vomit and bacteriological examination of the stools will clinch the diagnosis. Poisoning by corrosive sublimate may be similarly excluded.

Infantile diarrhœa and gastro-enteritis in young children may simulate cholera closely. Asiatic cholera is relatively infrequent amongst very young children, but a bacteriological examination may be essential for clearing up a doubtful case of acute intestinal infection. The clinical picture of cholera in children is very liable to be obscured by cerebral manifestations, and to be ascribed to meningitis or convulsions (3, 4).

Infections with bacteria of the paratyphoid group are stated by Castellani and Chalmers (5) to have produced typical rice-water motions, together with other symptoms simulating cholera. Bacteriological examination and immunity tests will differentiate the conditions.

The conclusive diagnosis of cholera depends on isolation and identification of the cholera vibrio in pure culture. The technique required for such differential examination is described on page 23.

In a typical case the condition passes into the *Stage of Collapse* (2) or *Algide Stage*, either by gradual accentuation of the results of the loss of fluid or by sudden failure of the circulation. In mild cases this stage does not occur, and in the severer cases it varies in rapidity of onset and in degree. It is characterized by—

Great weakness of the pulse and low blood pressure.
Complete suppression of urine.
Intense thirst.
Severe muscular cramps.
Lessening of the evacuations in frequency and amount.
Rapid increase of prostration, with cold, shrivelled skin and whispering voice.
More or less pronounced variation between the rectal and surface temperatures.

The mind usually remains clear, and the condition is particularly distressing to witness.

The differential clinical diagnosis in this stage is made from the conditions above described in connexion with the Stage of Copious Evacuations.

The Stage of Collapse lasts from a few hours to one or even two days. The longer it lasts the greater is the danger of serious later complications, and especially of uræmia. If it is survived, there slowly begins—

The Stage of Reaction (2).—The pulse improves slowly, the stools become less frequent and less copious, and thicken in consistency, the vomiting ceases, the surface temperature rises to—and soon exceeds—normal, and the restlessness gives place to a tendency to sleep. In the milder cases the secretion of urine begins to be re-established within 12 or 24 hours, although catheterization may be needed to prevent retention in the bladder. In severer cases re-establishment of secretion may be delayed for two or three days. The particular risks at this stage are uræmia and hyperpyrexia. Some rise of surface temperature occurs almost invariably. Minor degrees of this reaction usually subside in a few hours, but in severer cases the febrile state increases, and the so-called "cholera typhoid" condition may supervene, and last from several days to a fortnight or longer. This condition may simulate typhoid fever very closely, with "pea-soup," or greenish, motions of very offensive smell, low muttering delirium, dry, brown tongue, and accelerated respiration.

Differential diagnosis at this stage may require to be made from the after results of certain of the conditions already alluded to when describing the previous stages of the disease, and also from the following :—

(1) Uræmia, of non-choleraic origin.
(2) Pernicious malaria.
(3) Typhoid fever.

The complications and sequelæ of cholera are due principally to the interference with circulation during the collapse stage. They include parotitis ; sloughing of the cornea ; gangrene of the nose, mouth, vulva, penis, scrotum, fingers, or toes ; pneumonia ; pleurisy ; bronchitis ; pulmonary œdema ; dysentery and diarrhœa ; and persistent asthenia. "Pregnant women almost invariably miscarry, the fœtus showing evidences of cholera" (1).

MILD AND ATYPICAL FORMS OF CHOLERA.

Ambulatory cases probably occur during all epidemics. The motions never reach the "rice-water" stage, but retain more or less colour, there are no cramps, and the urine, though it may be lessened in amount, is never completely suppressed. Malaise is present for a time, but the attack subsides gradually without passing through the stages of collapse or reaction. These cases are not, of course, "carriers" in the strictly technical sense, but they may act as dangerous spreaders of infection.

"*Cholerine*" or "*choleraic diarrhœa*" is accompanied by rice-water stools for a short period, but the loss of fluid terminates before the production of collapse or suppression of urine, and is not followed by any definite reaction. Cramps may be present for a time, but not to any severe extent. These cases are liable to develop late uræmia if a pre-existing chronic kidney lesion is present.

Cholera Sicca.—In this somewhat rare and very fatal form of cholera, rapid collapse occurs, with little or no vomiting or purging. The rice-water evacuations may be found in large amount in the bowel, possibly accompanied by formed fæces in the lower bowel. The following notes on a case in Manila, in 1913, illustrate the peculiar difficulties which may attend clinical diagnosis of this form of the disease (6) :—

> On Saturday evening, 23rd August, he left his place of employment, apparently in good health. About noon the next day he was seized with violent pains in the stomach, which, later in the afternoon, increased in severity, and in addition marked pains began in the muscles of the calves and forearms. There was no diarrhœa. . . . The man was in a moribund condition when he arrived (at hospital) at about 10 p.m., and died a few minutes later. At the autopsy which was held in the morning of 25th August the typical pathological lesions of cholera sicca were present. The lower bowel contained a large amount of hard formed fæces. A liquid rice-water-like fluid was found in the ileum, cultures from which, prepared in accordance with the procedure recommended by the Conference Internationale d'Hygiene Publique, resulted in the isolation of the true cholera vibrio.

Cholera in Children.—The clinical picture of cholera in children is often atypical. Cerebral manifestations, such as convulsions, coma, jactitation, and cerebral irritability, are very common, and such cases are liable to be mistaken for acute or chronic enteritis, gastro-enteritis, entero-colitis, dysentery, acute or simple meningitis, "convulsions," or infantile beri-beri. Children are especially liable, as "missed casea," to play an important part in the spread of epidemic cholera (7).

Atypical Cases in an Outbreak.—Rosenthal (8), detailing his experiences in a cholera hospital in Philippopolis during the Balkan war, states that about a quarter of the 283 cases seen by him showed no cyanosis, or a trifling indication only. Some slight cases resembled enteritis without retraction of the abdomen, but had a typical blood picture. Rice-water stools were by no means uniformly present, even in the severest cases. Sometimes the stools were pasty, blood-stained, or blue. Tenesmus was present in only one case. The blood picture referred to is described as a valuable aid to diagnosis in the early days of illness. It included a very marked polymorphonuclear leucocytosis, the large lymphocytes being as numerous as the small, and eosinophiles being absent. The mortality rate of cases was 25·7 per cent.

Heiser (1913) states that since 1907 it has been noted in Manila that outbreaks of cholera have invariably been preceded by deaths which the pathologist attributed to acute nephritis, and in which he failed to find the cholera vibrio (9). He refers also to persons who died with symptoms of acute ptomaine poisoning; the *post-mortem* findings included signs of acute nephritis, but bacteriological examination for cholera proved negative. Munson (1915) records that a considerable proportion of the cholera-positive specimens secured from dead bodies during the 1914 outbreak in Manila were from deaths reported as due to enteritis, diarrhœa, dysentery, infantile beri-beri, and pulmonary tuberculosis, particularly the latter.

PROGNOSIS.

Rogers (10) thus classifies the factors influencing case mortality in cholera :—

1. Number of cases admitted with no pulse at the wrist.
2. Number of cases admitted with blood specific gravity of 1066 and upwards.
3. Number of cases requiring more than one intravenous injection.
4. Number of cases over 50 years of age.

He also records (11) the following results with the old and new treatment (*see* page 29) at various ages :—

**Age Mortality under the Old and the New Treatments.*

	Old System, 1895–1905.			New System, 1913–15.			Reduction of Mortality.
Age.	Cases.	Deaths.	%	Cases.	Deaths.	%	Per cent.
To 5 years ..	36	19	52.8	22	8	36.3 } 21.7	61
5 to 10 years ..				24	2	8.33	
10 to 20 ,, ..	150	80	51.3	121	17	14	73
20 to 30 ,, ..	468	274	58.5	197	44	22.3	64
30 to 40 ,, ..	273	174	63.7	134	28	20.9	67
40 to 50 ,, ..	111	77	69.4	43	16	36.5	47
Over 50	38	28	73.7	23	11	47.8	35

* ROGERS: *Lancet*, 31st July, 1915, p. 219.

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(11) Rogers, L. *Lancet,* 31st July, 1915, page 219.

III. THE BACTERIOLOGICAL DIAGNOSIS OF CHOLERA.

Collection of Material for Laboratory Examination.

When examining for carriers, if a stool is not available during the first few hours of observational control, and unless rectal swabbing is feasible, a mild purgative, a suppository, or an enema of boiled water should be administered (1). The resulting stool may be collected in a clean scalded bed-pan or chamber utensil. Care should be taken in selecting the purgative employed, owing to the possibility of converting a carrier into a case by the incautious use of saline cathartics.

A piece of solid fæces the size of a walnut, or from 2 to 4 ounces of liquid fæces, will be required. In the case of liquid fæces, the stool should be shaken or stirred if it has stood for any time, in order to ensure the distribution of any epithelial flakes, and to secure a typical sample.

Solid fæces may be transferred by means of a short sterilized wooden spatula. For liquid fæces a scalded glass spoon will serve well. For small amounts of liquid fæces a swab on a short handle may be employed.

The spatula, or swab, together with the collected material, are placed in a short sterilized wide-mouthed bottle, fitted with a new sterilized cork, labelled with the name, date, place, and other necessary identificatory particulars, and enclosed in a stout metal or wooden container for transmission.

No antiseptic should be added at any stage of the collecting process.

Extreme care should be taken to avoid personal infection when handling material of this nature. Upon completion the outside of the container should be swabbed with disinfectant, and all contaminated articles or material sterilized at once.

Transmission of Material.

Under ordinary conditions it is not desirable to transmit specimens by post, but where laboratory diagnosis cannot otherwise be obtained, the following extract from the *Commonwealth Postal Guide* will indicate the procedure to be followed :—

Commonwealth Postal Guide, October, 1914, *pages* 34 *and* 42.

46. (1) Applications for registration by the Postmaster-General of laboratories to which pathological specimens may be sent for examination must be made on the prescribed form, copies of which may be obtained from the Deputy Postmaster-General of a State.

(2) Pathological specimens addressed to laboratories registered by the Postmaster-General may be accepted for transmission by registered packet post, under the following conditions, viz. :—

(*a*) On the outside of every such packet there must be written or printed the words " Specimen for Bacteriological Examination."

(*b*) The liquid or substance forwarded for examination must be enclosed in a receptacle hermetically sealed, which receptacle must itself be placed in a strong wooden or metal case, in such a way that it cannot shift about, and with a sufficient quantity of some absorbent material (such as sawdust or cotton wool) so packed about the receptacle as absolutely to prevent any possible leakage from the packet in the event of damage to the receptacle.

(*c*) The packet must on no account be dropped into a letter-box or be sent by parcel post. Any packet of the kind found in the parcel post, or any packet of the kind, whether registered or not, found in the post, not packed as directed, shall be deemed to be posted in contravention of the *Post and Telegraph Act* 1901–1913, and dealt with accordingly.

(3) Any person who sends by post pathological specimens, otherwise than as provided by these Regulations, shall be liable to a penalty not exceeding Fifty pounds.

(4) A packet containing any pathological specimens shall not be accepted for transmission, or, if found in the post, shall not be delivered unless addressed to a laboratory which has been registered by the Postmaster-General in accordance with this Regulation.

LARGE SCALE OPERATIONS FOR CARRIER DETECTION.

These may require to be carried out on a large scale, and with a minimum of detention for passengers. The technique adopted at the New York Quarantine Station during 1911–12 was as follows (2):—

(1) Tubes of Dunham's solution were taken aboard in wire baskets, each holding 100.

(2) Swabs, similar to ordinary diphtheria swabs, accompanied the tubes, in sterilized paper-wrapped bundles of 50 or 100.

(3) The passengers were separated by sexes, women and children being handled by women doctors and nurses. A numbered card was distributed to each passenger.

(4) A swab was moistened in peptone water and inserted well above the anal sphincter, endeavour being made to obtain a well-fæcal-stained specimen.

(5) The swab was dropped into a peptone tube, and the latter numbered to correspond with the identification card. The tube and swab were then forwarded to the laboratory.

(6) After receipt at the laboratory the tubes were (*a*) incubated for six hours at 37° C., (*b*) sub-cultured into fresh peptone water, and (*c*) incubated for nine or ten hours.

(7) Smears from the sub-cultures were stained with dilute carbol fuchsin and microscoped.

(8) Any vibrio found was examined for motility, and planted in alkaline agar (3-10ths to 5-10ths alkaline to phenolphthalein).

(9) After incubation for from 12 to 24 hours the plates were examined, and any suspicious-looking colonies tested for agglutination against an anticholera serum of high titre.

THE POST-MORTEM APPEARANCES OF CHOLERA (3, 4, 5).

The principal macroscopic details to be noticed in an average case of cholera which has died during the stage of collapse are the following:—

(1) The eyes are sunken, the skin of the hands corrugated, and the nails cyanotic. Rigor mortis is usually strongly marked. In previously healthy subjects the body is generally well nourished.

(2) On opening the body, the tissues are markedly dry and oligæmic. The blood is thick, and coagulates poorly. The outer surface of the intestines is usually of a pink tint.

(3) The peritoneal and serous surfaces generally are dry, and sticky to the touch. This is especially marked on the peritoneal coat of the small intestine.

(4) The portal system is engorged, the blood being thick and tarry-looking. The parenchyma of the spleen and liver may be shrunken and dry. The gall bladder is frequently congested with thick green bile, and the mucous membrane at the entrance of the bile duct to the duodenum is swollen.

(5) The intestines will probably contain rice-water-like or milky fluid, without bile-staining or formed fæces. In cholera sicca this fluid may be present in large amount. In cases of some days' standing the bowel may contain a foul-smelling fluid.

(6) The stomach and small intestine usually show the changes associated with an acute catarrhal enteritis, but the lesions may vary considerably in nature and extent. The solitary follicles of the ileum are often enlarged.

(7) The urinary bladder is generally contracted and empty. The kidneys may show a parenchymatous nephritis.

Bacteriological examination may be necessary to confirm doubtful cases. It is necessary to bear in mind that the mere presence of cholera vibrios in the intestinal content does not indicate, by itself, that the person was actually suffering from cholera.

The removal from the cadaver of material for bacteriological examination at a distance is best carried out as follows (6) :—

> Three loops of intestine, each about 4 inches long, are ligated at each end and removed, one from the middle part of the ileum, one about 6 feet above the ileocæcal valve, and one immediately above the valve. The last mentioned is the most important. The material is packed in freshly-boiled stout wide-necked bottles, with boiled corks. No disinfectant should, of course, be used. As the cholera spirillum tends to die off within 12 to 24 hours, it is advisable, where any delay is anticipated in transmission, to also inoculate an agar or serum slant with material from the ileum, and to forward it with the gut specimens.

LABORATORY DIAGNOSIS OF CHOLERA.

During an active epidemic diagnosis of the ordinary run of cases is, for practical epidemiological purposes, readily possible from clinical observation alone. The conclusive diagnosis of doubtful, obscure, or sporadic cases, or of cases where —as in quarantine practice under Australian conditions—it is of vital importance that the presence or absence of cholera in any given clinical picture or set of conditions should be authoritatively determined as a basis for further action, depends wholly upon the isolation and identification of the cholera vibrio in pure culture. This is also true with respect to suspected carriers. Any such examination requires to be made by a skilled bacteriologist, possessing at hand all requisite materials and apparatus.

Negative results from the examination of a single specimen cannot be taken as definitely and finally excluding cholera. On the other hand, vibrios, which bear a more or less close resemblance to cholera, are said to be not uncommon amongst the intestinal flora of healthy or diseased persons, particularly during a cholera outbreak. Rosenau advises that : "Dependence should not be placed on morphological characters, cultural peculiarities or pathogenicity in laboratory animals, for these do not furnish the means of certainly defining the cholera vibrio" (7). The sub-committee of the Technical Committee of the Paris Convention of 1912 laid down the following rule (8) :—

> In practice it can be taken as a rule that every "choleriform vibrio" may be accepted as being a cholera vibrio if it exhibits either of the following characteristics :—
>
> (1) If it is agglutinated in a dilution of at least 1 in 1,000 by a serum of which the activity is equal or superior to 1 in 4,000.
>
> (2) If it shows the reaction of Pfeiffer.

A similar rule was enunciated in a report presented to the Permanent Committee of the International Office of Public Hygiene by a Commission comprising Ruffer, Calmette, Gaffky, Geddings, Murillo, Praum, and Pottevin, and adopted by the Committee in October, 1911 (9).

McLaughlin and Whitmore, working in the Philippines and following up the results of Zlatogoroff and Barrenscheen, found that all vibrios which agglutinated with a 1-in-200 dilution of specific anticholera serum were cholera vibrios, and that no non-cholera vibrio agglutinated at less than 1 in 10 under these conditions. Four of the vibrios worked at did not agglutinate equally well with all anticholera sera. Attempts to develop agglutinability to anticholera serum amongst " cholera-like " vibrios failed (10).

Stamm (1914) records that certain genuine cholera strains which normally agglutinated at a titre of 1 to 20,000, failed to agglutinate at a titre of 1 to 50 after they had been passed through water in a particular manner. These new strains did not agglutinate with serum of their particular strain, but did so with serum produced by their injection into rabbits. These latter sera agglutinated not only the variants, but also the original cholera strain, and other genuine cholera strains as well. Removal of agglutinating power by water-passage required over two months, and was only irregularly produced (11). The apparent result was the removal of power to react with the specific agglutinin, but retention of the specific agglutinogenic property of genuine cholera strains. If Stamm's work is confirmed it will be necessary to regard non-agglutinating water vibrios which contain specific agglutinogens as true cholera vibrios.

Craster (1914) has followed out the work of Zlatogoroff, Horowitz, Barrenscheen, and Carapelle, pointing to the possibility of developing agglutinating powers in certain water strains of cholera-like vibrios. Pottevin showed in 1913, from study of vibrios isolated at El Tor, that agglutinating and non-agglutinating vibrios could exist simultaneously in the same patient. Craster concludes that cholera-like non-agglutinating vibrios are frequent in the intestines of healthy persons and in river and well waters during cholera epidemics. He points out that the absence of agglutinability in a vibrio isolated from a suspected source does not define conclusively its non-cholera nature, and that no vibrio can be regarded with assurance as a truly saprophytic variety until it has been subjected to a procedure which will induce the return of agglutinability. Cholera-like vibrios which eventually develop agglutinating properties are, according to Craster, true cholera vibrios (12).

Pottevin (1915) considers that every carrier of vibrios of any kind should be isolated as a cholera-carrier pending laboratory investigation of successive cultures. Examination of carriers should be repeated every 24 hours until two consecutive negatives are obtained (13).

Castellani (1915) records the isolation of a vibrio biologically different from the cholera vibrio, to which he gives the name of *vibrio kegallensis* Cast. 1913. This vibrio was recovered from cases of paracholera, and is regarded by Castellani as being the probable cause of certain cases of cholera-like disease (14).

The Permanent Committee of the International Office ot Hygiene has recorded the following opinion :—" If in a locality there appear repeated attacks of a disease presenting the clinical symptoms and anatomo-pathologic lesions of cholera, and the bacteriological examination reveals in the fæces of the patients and in the intestinal contents of cadavers a choleriform, vibrionic flora, even if the vibrios isolated are not agglutinated in the proportion of 1 to 1,000, and do not give the Pfeiffer reaction, it is indicated in these exceptional conditions to repeat the bacteriological examination until all doubt is removed " (15).

At the present stage of knowledge, and under Australian conditions, the uncompromising isolation of vibrio carriers until the fullest laboratory investigation has been completed will afford the only safe course where any suspicion or doubt exists concerning the possible existence of cholera.

LABORATORY TECHNIQUE.

Strict rules for bacteriological procedure are impracticable and undesirable, but certain general lines of investigation have been laid down by various competent authorities, which will permit in the great majority of cases a positive diagnosis within 36 hours at most. Operations for the critical determination of a negative result will necessarily occupy a longer period.

The permanent Committee of the International Office of Public Hygiene recommends (1911) the following procedure (16) :—

(1) When mucous flakes are available for examination, a microscopical examination of the same in stained preparations and in the hanging drop.

(2) Isolation of the vibrios, employing for the purpose agar media at a temperature of 37° C.

- (*a*) Plant plates of ordinary alkalinized agar, and of Dieudonné's medium, using for the latter a risiform particle or an equivalent quantity of fæces.
- (*b*) Plant in 50 c.c. of peptone solution, 1 c.c. of fæcal matter. After six hours in the incubator (or twelve to eighteen hours if need be) at 37° C., take several loopsful from the surface and plant with them several plates of Dieudonné medium and ordinary agar.
- (*c*) Investigate the agglutination reaction, using drops from the isolated colonies; investigate the properties belonging to cholera vibrios; and secure pure cultures.

(3) Demonstrate the character of the vibrios obtained in pure culture, by the agglutination reaction or the Pfeiffer reaction.

The Committee points out that the conditions are much more favorable to the discovery of vibrios if fæces or intestinal contents are collected as early as possible in the attack, or secured from the cadaver as early as possible after death. Examinations made from the small quantity of material collected by a sound introduced into the rectum, in the living body or from the cadaver, are unreliable.

Pottevin (1915) outlines the method used by him as follows (17) :—

(1) If fæces are solid about 1 c.c. is mixed with a few drops of broth and sown in a peptone water tube, or better, in peptone gelatine.

(2) After six hours the growth is plated on Dieudonné and incubated at 37° C.

(3) After twelve hours' incubation the plates are examined. If no colonies are present the result is regarded as negative. If colonies are present, they are examined for vibrios, inoculated into ordinary gelatine, and incubated for from fifteen to eighteen hours.

(4) For agglutination-determination, a strong cholera-serum (1 in 5,000) is used. A little of the Dieudonné culture is added to a drop of the diluted serum. In about 30 minutes at room temperature the drop appears to consist of a clear liquid in which the agglutinated vibrios form a residue resembling a network of threads. A test drop of normal saline mixed with an equivalent quantity of culture should preserve its evenly-clouded appearance. If definite agglutination occurs the organism is cholera. If negative, the test is of no value.

(5) For determining the titre of agglutination a series of serum-dilutions is prepared n normal saline, ranging from 1 in 200, 1 in 500, 1 in 1,000, &c. Two checks are also made, one with the culture to be tested and normal horse-serum, one with anticholera serum and a type cholera vibrio.

(6) To 1 c.c. of the diluted serum in tubes is added 1 c.c. of an emulsion formed from the eighteen-hour gelatine culture in 25 c.c. of normal saline. A positive reaction is shown after two hours in the incubator at 37° C., by deposit of the vibrios at the bottom of the tube, leaving a clear supernatant fluid.

Pottevin points out that young cultures are liable to produce pseudo-agglutination, and that those of less than fifteen hours' incubation should not be used; impure cultures do not yield a characteristic reaction. Every vibrio which is agglutinated by 1 in 1,000 is regarded as cholera.

Castellani and Chalmers (1913 ed.) recommend the following method of examination of suspected material (18):—

(1) Make films from the rice-like flakes, and stain with diluted Ziehl carbolic fuchsin (1 in 50) for ten minutes, or with Löffler's blue five minutes. If a large number of curved rods be present, cholera may be *suspected*, but a definite diagnosis should never be based on the simple microscopical examination, as comma-like germs are found in many cases of ordinary diarrhœa, and in even in normal stools.

(2) Take a rice-like flake and smear it direct on to the surface of MacConkey's lactorse-agar plate, using a sterile bent glass rod or Kruse's platinum pencil. Inoculate with the same rod or pencil, without recharging, the surface of two or more plates, and incubate at 35° C.

The colonies of the cholera and the cholera-like vibrios develop on MacConkey's medium as delicate, small, yellowish, roundish dots within twelve to eighteen hours. Any suspicious yellowish colony should be examined, and the germ investigated as regards the following characters:—

(*a*) *Motility.*—The cholera vibrio is very actively motile.

(*b*) *Morphology.*—The cholera organism is often bent, comma-like (*i.e.*, the German comma, not the English one), but may be straight, bacillus like.

(*c*) *Agglutination.*—A strong anti-cholera serum should be used. We use the serum derived from hyperimmunized rabbits. This serum in Ceylon generally shows an agglutination limit which varies between 1 in 5,000 and 1 in 7,000 on the various strains of cholera vibrio kept in the laboratory. Any vibrio found in stools which is agglutinated by this serum in a dilution not less than 1 in 4,000 can safely be considered, as a rule, to be the true germ of cholera. In doubtful cases all the cultural characters should be studied and Pfeiffer's test and Castellani's absorption test should be carried out.

(3) Inoculate four tubes of peptone water with the suspected stools, the first with ¼ c.c.; the second with ½ c.c.; the third with 1 c.c.; and the fourth with 2 c.c.; or inoculate each of two Erlenmeyer flasks, capped with sterile filter paper without wool plugs, with 1 c.c. of the stools. The formation of a scum on the surface of the medium within eight to ten hours is suspicious of cholera. The pellicle, and the upper portions of the medium should be examined microscopically for the presence of vibrios, and MacConkey agar, or ordinary agar plates, should be made for further examination as already described. The peptone water should be tested for the presence of indol, adding a few drops of pure sulphuric acid. In true cholera the indol reaction is generally present eight to ten hours after inoculation.

(4) Inoculate the surface of three ordinary serum-tubes with the suspected stools, and incubate at 35° C. If, within sixteen hours, there is no zone of liquefaction in the medium, cholera may be practically excluded. If there is liquefaction, this may be due to the presence of cholera or other serum-liquefying germs, or to the stools containing an amount of proteolytic substances. The liquefied serum may be plated on MacConkey or ordinary agar plates, and any suspicious colony further investigated.

(5) Dieudonné's special strongly alkaline blood agar may be used for the isolation of the cholera vibrio in fæces. On this medium the cholera germ grows well, while the coli and coli-like organisms scarcely vegetate. Of course the colonies which grow must be carefully investigated, as already described.

Rosenau gives the following method for bacteriological investigation of suspected cholera material (19) :—

> The suspected material should be planted on the surface of ordinary alkaline agar, or upon Dieudonne's medium, using one of the small rice-like flakes or an equivalent quantity of fæces.
>
> When it is suspected that the cholera vibrios are few in number, they may be enriched by first planting in Dunham's solution. Approximately 1 c.c. of the fæcal matter should be placed in 50 c.c. of the peptone solution. This is incubated at 37° C., and in from six to eight hours a loopful is taken from the surface and transferred to ordinary agar or Dieudonne's medium. Suspicious colonies are fished and studied further. The agglutinative qualities of any suspicious colony are tested against a specific agglutinating serum having a titre of 1 : 4,000. With this any organism which is agglutinated in 1 : 1,000 may be considered true cholera. Organisms agglutinating in dilutions of 1 : 500 and 1 : 1,000 should be considered as doubtful.

In any doubtful case Pfeiffer's reaction should be tried. This is specific, but requires a somewhat lengthy preparation of test animals which renders it impracticable for prompt diagnosis of the first cases of an outbreak. The procedure is as follows :—

> Guinea pigs are immunized by the subcutaneous injection of increasing doses of a cholera culture about once a week until they are resistant to large doses of a fresh virulent strain. This usually requires at least three or four injections. Some of the live micro-organisms to be tested are now injected into the peritoneal cavity of the immunized animal, and from time to time minute drops of the injected material with the peritoneal exudate are withdrawn by capillary tubes and examined under the microscope. With a positive reaction the vibrios soon lose their motility, become swollen, and agglutinate into clumps of balls, which become pale in colour. Finally the vibrios disintegrate and are dissolved in the peritoneal fluid. With a highly immunized animal the process usually takes about twenty minutes, and the animal is unaffected.
>
> A control is furnished by the injection of a like quantity of the cholera culture into the peritoneal cavity of a non-immune guinea pig. Neither immotilization, disintegration, nor dissolution occur, and the animal ultimately dies as a result of the infection.

Bordet demonstrated that this reaction will also occur *in vitro* when the serum of an immunized animal is mixed with cholera organisms. It is applied as follows (20) :—

> A series of dilutions of the serum of the suspected person is prepared, usually 1 in 100, 1 in 500, and 1 in 1,000, and mixed with guinea-pig serum (alexines) and microbial emulsion. Controls are made from the same quantity of microbial emulsion, alexines, and normal serum. All are put into the incubator at 37° C., and examined in hanging drop after three to four hours. After eighteen hours the control tubes will contain abundant living vibrios, but those of the serum to be tested will, if the reaction is positive, contain only vibrios which have undergone very complete transformation.

Manson (21) states that the Bordet-Gengou reaction has been advantageously employed in the detection of cholera carriers. This reaction " is based on the fixation of the complement, using a culture of the vibrio as an antigen. The following mixtures are prepared in three test tubes :—Nos. 1 and 2 contain 0.2 c.c. suspension of cholera vibrio, and 0.6 c.c. suspected person's serum (heated to 56° F. for half-an-hour), and 0.1 c.c. complement (guinea-pig's serum) ; tube 3, a similar mixture, with the substitution of normal person's serum. These tubes are shaken and incubated for half-an-hour. Then 1 c.c. of mixture of a serum hæmolytic to sheep's corpuscles (heated to 56° F. for half-an-hour), and one volume of washed sheep's corpuscles. Should the suspected serum be that of a cholera carrier, the complement in tube 1 will be fixed, and no hæmolysis occur, whereas in tube 3 it will be free and hæmolysis will take place."

SPECIAL MEDIA FOR CHOLERA INVESTIGATION.

Dieudonne's medium is prepared as follows :—

Sol. A.—Equal parts of the normal solution of potassium hydroxide and defibrinated ox blood are mixed and sterilized in the autoclave.

Sol. B.—Ordinary nutrient agar, exactly neutral to litmus.

Seven parts of B are mixed with three parts of A, and poured into Petri dishes. The plates should not be used immediately after their preparation. Dieudonne recommends keeping them several hours in the incubator at 37° C. uncovered and face down, or to heat them for five minutes at 65° C. Equally good results can be obtained by keeping them 48 hours at room temperature. The surface of the agar should be slightly dry. Once in condition the plates should be used in a period not exceeding five or six days (Rosenau, 22).

The following formula for Dieudonne's medium is given by Ledingham and Arkwright (23) :—

Normal potassium hydrate,
Defibrinated ox blood ; equal parts.
Mix and sterilize by steam. Add 30 parts to 70 parts of neutral agar. Mix and pour into plates, which must be kept at least 24 hours before use, and should be dried slightly.

Pilon's modification of Dieudonne's medium is said to enable the material to be used at once. His formula is—

Defibrinated blood (pig's, goat's, or rabbit's).
Twelve per cent. solution of crystalline sodium carbonate ; equal parts, not sterilized.
Add 3 parts to 7 parts of 4-per-cent. neutral agar ; mix ; pour into plates.

The peptone water used for enrichment is best prepared (Kolle and Schurmann, 1911) by making up a stock solution as follows :—

Peptone (Witte), 100 grammes.
Sodium chloride, 100 grammes.
Potassium nitrate, 1 gramme.
Crystals of carbonate of soda, 2 grammes.
Distilled water, 1 litre.

For use the above must be diluted 1 to 9 with sterile distilled water, put in tubes each containing 10 c.c., and again sterilized (23).

Lentz (24) gives the following formula for preparing the ingredients of Dieudonne's medium in dry form :—

> Fresh defibrinated ox blood is mixed with an equal quantity of normal potash solution and placed in a steam bath for an hour. The liquid is evaporated in the shallow trays of a Faust-Heim apparatus under an air current of 37° C., the residue being ground to powder and kept in a well-stoppered bottle. Three grammes of this powder dissolved in 30 c.c. of water and added to 70 c.c. neutral agar give a Dieudonne blood-agar ready for immediate use capable of keeping for eight to ten days, and possessing all the elective affinities of the normally prepared Dieudonne medium. The powder was retested after four weeks, and found to give as good a medium as when freshly prepared.

Schobl (25) has pointed out that the morphology of the cholera vibrio is apt to vary with the chemical reaction of the culture medium, and recommends the use of three different reactions for peptone media, corresponding to the reaction of the cholera fæces from which the specimen is taken, as recommended by Ohno. He also states that Kraus' medium has a decided advantage over peptone solution, particularly in searching for carriers. Kraus' medium is practically Dieudonne's in liquid form. It is composed of 3 c.c. of alkalinized blood mixed with 6.7 c.c. of neutral broth. The mixture is not boiled.

The peptone gelatine recommended by Pottevin is composed as follows :—Dry peptone, 1 gramme ; marine salt, ½ gramme ; gelatine, 2 grammes ; crystallized carbonate of soda, 0.2 gramme ; distilled water, 100 grammes.

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IV. THE TREATMENT OF CHOLERA.

If a case is encountered in the stage of premonitory diarrhœa astringent remedies may be tried, but opium should not be used where there is any suspicion of cholera. The reason of this departure from former practice is thus stated by Rogers. "If collapse ensues it may remain unabsorbed until the circulation revives in the stage of reaction, which is just the time it is most actively dangerous." When Koch was experimenting with cholera on animals, he used opium to quiet the intestine, and to thus give the vibrios an opportunity of multiplying, and, despite many of the older writers, the use of opium in any form is decidedly unsafe in cholera.

The principal necessity is the treatment of cholera is the restoration of the fluid and chlorides lost in the evacuation. Mere restoration of fluid alone is not sufficient, and isotonic intravenous saline injection injections have proved a failure when used in the stage of collapse. It is of interest to note that isotonic intravenous treatment was used as far back as 1832 by Macintosh and Latta, in Edinburgh, but without much success.

The method of intravenous injection of hypertonic saline solutions with administration of permanganates by the mouth devised by Professor Leonard Rogers, of Calcutta, has proved of great practical value. The following table gives the comparative results obtained in the treatment of 3,813 cases of cholera by different methods over a series of years at Calcutta under Professor Rogers' supervision :—

*Results of the Hypertonic and Permanganate Treatment of Cholera compared with former Methods (1).

Years.	Cases.	Deaths.	Mortality.	Recoveries.
			Per cent.	Per cent.
Rectal and Subcutaneous Salines.				
1895 to 1905	1,243	783	59·0	41·0
Normal Salines intravenously.				
1906	112	57	51·9	49·1
Rectal and Subcutaneous Salines.				
1907	158	94	59·5	40·5
Hypertonic Salines intravenously.				
1908 to July, 1909	294	96	32·6	67·4
Hypertonic Salines plus Permanganates.				
August, 1909, to December, 1912	436	124	28·4	71·6
1913	200	49	24·5	75·5
1914	222	49	22·1	77·9
1915 to June	145	29	20·0	80·0
August, 1909, to June, 1915	1,003	251	25·0	75.0

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* Rogers.

Rogers (2) postulates that a blood pressure of below 70 mm. indcates the presence of a dangerous degree of collapse necessitating an intravenous saline injection. He also points out that very valuable information as to the necessity for injection may be obtained from an estimation of the specific gravity of the blood as ascertained by adding a drop to a series of comparative solutions of glycerine and water, titrated to each two degrees of specific gravity from 1040 to 1076. " If the specific gravity is over 1060 in addition to the blood pressure being low, then a copious intravenous saline injection can be safely given, for much fluid has evidently been lost from the system. Should the specific gravity be over 1065, it is usually advisable to give an intravenous injection, even if the pressure be a little over 70 mm."

In the absence of a sphygmometer, Rogers regards restlessness, accompanied by a weak pulse and with severe and repeated cramps, especially if cyanosis of the fingers and lips is present, as a sure indication of urgent necessity for intravenous injection.

The solution employed is composed of—

Sodium chloride, 120 grains (8 grammes).
Calcium chloride, 4 grains (0.25 grammes).
Potassium chloride, 6 grains (0.4 grammes).
Water, add 1 pint (568c.c.).

TECHNIQUE OF INTRAVENOUS INJECTION.

The following procedure is employed by Rogers. The solution and all apparatus are carefully sterilized, and the top of the container for the solution is covered with a piece of sterile gauze after filling. No anæsthetic is necessary, as the patient at this stage is usually far to ill to heed much what is done to him. The apparatus employed consists of a graduated bulb connected by a length of rubber tubing with a special tapered transfusion cannula provided with a stop-cock.

In all cases, except children under ten, one of the veins of the bend of the elbow will serve the purpose, but, if necessary, the long saphenous vein, or the large vein over the internal malleolus of the ankle may be employed. If, for any reason, the cannula cannot be made to enter these, the exposed vein may be punctured with a large hypodermic needle attached to the transfusion apparatus, the bulb being well raised to expedite flow. A small-calibred cannula may be extemporised by drawing out a piece of glass tubing and cutting it off to the required diameter and length.

All apparatus and material being ready, the site of operation is cleansed and sterilized, and a piece of bandage tied tightly with a slip knot above the proposed site of injection in order to distend the vein. The vessel is exposed by an incision an inch or so in length, and carefully dissected out. A double strand of silk is passed under it, and the lower strand used to tie off the distal end of the vein. The other strand is looped loosely round the upper part of the vein, ready to be tied round the cannula as soon as it is inserted. The vessel is then ready for opening.

Except in rare cases where the circulation through the extremities has almost ceased, the vein will be distended with blood. The superficial wall is seized with a fine forceps, and an oblique cut, sloping upwards and backwards beneath the forceps, is made with a pair of scissors through half the circumference of the vein. This forms a small flap which can be held open with the forceps.

The cannula connected with the bulb, and full of the solution, is passed under with the other hand, and, guided as it is by the undivided segment of the vessel wall, must enter the lumen if it is of suitable size to do so. After being passed in for about an inch, the upper strand of silk is tied round it. The entry of air is prevented by allowing a full stream to run through the cannula just before it is inserted. The bandage above the wound is loosened as soon as the cannula is in place, and the fluid allowed to run in. A piece of sterile gauze is laid over the wound during the injection to prevent contamination.

For average cases the temperature in the container should be 100° F., in order to approximate to the normal body temperature after allowing for the slight cooling during passage through the tubing. If the rectal temperature is a degree or more below normal, the solution should be at a temperature of from 102° to 104° F., being lowered if the surface heat returns. If, on the other hand, the rectal temperature is over 100° F., the solution may be run in at several degrees below normal. Rogers records recovery after injection of solution at 86° F. with a rectal temperature of 105.2° F.

The saline may, as a rule, be given at the rate of a pint in five minutes, or 4 ounces per minute. With marked collapse it is run in quickly at first, to restore the pulse as soon as possible.

About 4 pints are required in an averagely severe collapse stage in an adult male, to replace the loss in blood volume, and to give a slight excess against contingencies. For females, about 3½ pints will suffice, and for children from ten to fifteen years of age 2 pints. A normal blood pressure with a full-bounding pulse should be aimed at.

Watch must be kept for any sign of distress, especially in old people. Severe headache, or oppression in the chest with quickened breathing, are indications for immediate slowing of the rate of injection.

Repetition of intravenous injection may be required by return of collapse. A blood pressure below 70 mm. and restlessness, with feeble pulse, are the principal indications for another injection.

The routine administration of permanganates is advised by Rogers. An unlimited quantity of a solution of from 1 grain to 6 grains of permanganate of calcium per pint of water, beginning with the weaker strength and gradually increasing the permanganate, may be given to the patient as a drink during the intense thirst of the acute stage. Not more than 2 or 3 ounces should be given at a time in order to lessen the liability to vomiting.

In addition to the permanganate drink, pills of potassium permanganate are given by Rogers as follows:—Immediately on admission one pill containing 2 grains of the salt is given every quarter-of-an-hour for two hours, and then one pill every half-hour. Any vomited are replaced without delay. They are continued until the stools become green and less copious. The dosage may be safely increased. The following formula is employed at the Calcutta Medical College Hospital :—

Potassium permanganate, 2 grains.
Kaolin and vaseline, q. s.

Coat with salol one part and Sandarach varnish five parts, or with keratin.

The pills should be freshly made.

Bishop (1913) records good results from a modification of Rogers' method (3). Instead of making the injection intravenously, he inserts a special trochar-cannula through an eschar made with carbolic acid about 1 inch below and to one side of the umbilicus. The abdominal wall is previously drawn taut by an assistant, who grasps it between the thorax and pelvis on each side. The solution is allowed to flow in to the peritoneal cavity, usually until the patient feels a desire to micturate. About 80 ounces is given in an average adult case, and 40 ounces to children.

METHOD EMPLOYED IN MANILA.

The intravenous injection of saline solution has been used largely in Manila. The following description of the technique employed at the San Lazaro Hospital has been furnished by the courtesy of Dr. Heiser, Director of Health, Philippine Islands :—

Saline Solution in Treatment of Cholera.

All severe cases of cholera are given saline solution intravenously. The ordinary normal salt solution may be used, or other approved mixtures. During the last epidemic we used a solution composed of 45 per cent. sodium chloride and 25 per cent. sodium bicarbonate, and we have also used a solution composed of sodium sulphate 10 gm. ; sodium chloride, 5 gm. ; and water, 1,000 c.c These solutions are of course always made from chemically pure drugs, in distilled water, and very carefully sterilized.

The amounts given at one injection vary from a few hundred c.c. to 1 or 2 liters, depending on the condition of the patient ; enough should be given to bring the blood pressure nearly or quite to normal. As much as 10 or 12 liters may in exceptional cases be given in 24 hours ; but the average amount is probably about 2.5 liters.

This solution is given from the bottles in which it is sterilized, by means of rubber tubing, and a double-tubed cork. The undersigned has usually given the solution by exposing the internal saphenous vein where it is most superficial, near the ankle joint, using a double-curved cannula. Any ordinary small cannula from an aspirating set may be used, or any needle from 1 to 2 or perhaps 3 mm. bore, if the point is blunted so that it will not catch in the wall of the vein.

The solution should be at a temperature of at least 101° or 102° F., and somewhat warmer in the bottle, as it will cool more or less in the tube.

It should not be given too fast, say, from fifteen to twenty minutes to half or three-quarters of an hour for a liter—watching the pulse and respiration carefully. The rate of flow may be regulated by the height of the bottle and by compressing the tube, and also by the bore of the needle. One advantage of a small needle is that the solution is not likely to be given too rapidly. In our last series of cases a very large part of the injections were given into the unexposed vein, usually the median cubital, an ordinary hypodermic or serum needle being used. This method has the advantage of avoiding cutting down on the vein, and is not particularly difficult.

When nephritis accompanies or follows cholera a stronger solution of sodium bicarbonate may be used.

We have used lately, also, continuous proctoclysis by the drop method, using normal salt solution at or somewhat above the normal body temperature. This not only seems very good treatment as regards the nephritis, but furnishes fluid continuously for the tissues. This method is particularly useful when treating children.

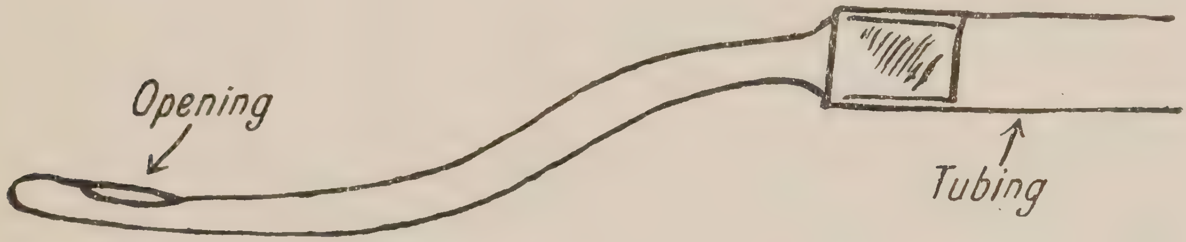
Of course, cardiac stimulants are used when indicated, and a small dose of morphine is occasionally given when patients are inclined to be restless.

When hot-water bags are used great care should be taken as patients in the collapse stage of cholera are very easily burned.

A rough sketch of the double-curved cannula, showing approximate size and shape, is enclosed.

(Sgd.) A. P. Goff,
Chief, San Lazaro Hospitals Division,
Bureau of Health, Manila, P.I.

11th December, 1914.



CANNULA.

Improvised Methods of Perfusion.

Intravenous perfusion may on occasions be carried out successfully under circumstances of considerable practical difficulty. Cadbury and Hofmann (4) have described how they treated 44 cases in a native Chinese lunatic asylum by improvising apparatus and material from raw salt, kerosene tins, boiled water, an antitoxin needle, some rubber tubing, and a few domestic utensils. There were no trained assistants, and the demented patients were operated on on the bare floor. The results of this somewhat heroic proceeding were stated as follows :—

Twenty-seven transfused, 74 per cent. recovered, 26 per cent. died.
Seventeen not transfused, 35 per cent. recovered, 65 per cent. died.

The authors explain that some of the non-transfused cases were purposely left, as they were apparently so mild as not to require vigorous treatment.

A salvarsan apparatus fitted with a large container to hold 2 quarts will serve well for intravenous saline injection.

It should be clearly realized that there is as yet no infallible remedy for cholera, and that certain forms of the disease, especially if they come under treatment late, are practically impossible to save. Nevertheless, remarkable results may be obtained by the employment of Rogers' treatment, and wherever cholera is to be dealt with the necessary solutions and apparatus should be kept in readiness for prompt use.

Auxiliary Treatment.

Bishop (5) gives 20 minims of pituitary extract (P.D.) in half-an-ounce of water when the case is first seen, and repeats it every four hours until micturition is re-established. In urgent cases it is given hypodermically.

The relief of thirst by small pieces of ice and by free administration of the calcium permanganate drink should be carefully attended to. There is no need to restrict the quantity of fluid, so long as it is not given in sufficiently large amount at any one time to provoke vomiting.

Hyperpyrexia may require copious iced-water rectal saline, ice to the head, and cold sponging.

The diet in cholera should be limited for the first three days to barley water alone. In a favorable case soup may be added on the fourth day, but too early administration of animal food is apt to cause relapse. Whey, jelly, Benger's food, and thin farinaceous foods may also be tried after the third day. Milk is not usually well tolerated. When the acute diarrhœa has stopped for two days or more, custards and other light food may be given cautiously.

Renault (1914) claims to have secured good results in cholera with chlorhydrate of emetine in hypodermic injections (6). A solution of 1 : 100 was used in a dosage of 4 centigrammes per day in patients of 25 years of age and over ; 3 centigrammes per day in patients of from 15 to 25 ; 2 centigrammes per day from ages 8 to 15 ; and 2 centigrammes from ages 1 to 8. Rogers (1915) tested Renault's method in a series of 32 cases against a check series comprising an equal number of comparable cases, using hypodermic saline in both series (7). He concluded that emetine showed no influence for good or ill.

Dubalen claims satisfactory results with from 3 to 5 mg. of adrenalin in solution (8).

Rogers (1) has recently worked with atropine and sodium bicarbonate for the purpose of lowering mortality from post-choleraic uræmia. The latter salt was originally employed by Sellards in the Philippines (9).

Successful results have been claimed for the use of kaolin, alone or supplemented by charcoal. The dosage for adults is stated as 125 grammes of very finely pulverized kaolin administered after stirring into half a tumbler of water and repeated in three hours (10).

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V. THE MODE OF SPREAD OF CHOLERA.

Up to recent years operations against cholera were based, at first on measures of close quarantine of persons and goods, and at a later date upon the assumption that the virus of the disease was normally or usually saprophytic, and was conveyed to mankind particularly by water. These lines of attack failed for reasons which are sufficiently obvious in the light of modern knowledge, and for equally obvious reasons measures directed with intelligence and precision against the human reservoirs of the disease have been brilliantly successful wherever it has been possible to apply them on a sufficiently large scale. The situation has been well summed up by Greig as follows (1) :—

> In regard to the prevention of cholera, the lead which the recent bacteriological research gives to the practical sanitarian is to so arrange his tactics as to concentrate his attack on the human element, because this dominates the situation. The human reservoir is in a position to supply an adequate dose of the poison to the various distributing channels—water, milk, flies, &c., and so initiate epidemics of cholera. Thus, a water supply may fulfil in every respect the requirements of a modern hygienist, but should it happen that a single " porter " of organisms is employed on the waterworks there is very great risk of this concentration of the poison invalidating all the numerous and costly precautions taken to provide a pure supply, by adding to the water on its way to the consumer an infective dose of the virus. The same statement would hold good in regard to milk supplies, food supplies, &c. . . . . The problem of the prevention of cholera, shortly stated, is the protection of mankind from man.

The spread of cholera is closely analogous to the spread of typhoid, and where one is able to remain endemic the other may be expected to maintain its footing if once introduced.

Viability of the Cholera Vibrio.

In Fæcal Matter.

Greig (1914) observed the viability of the cholera vibrio in typical rice-watery stools, kept in the dark under suitable conditions to prevent evaporation and examined daily (2). The vibrios remained alive and recoverable for an average of 7·7 days in cold weather (February) and 1·2 days in hot weather (June). The maximum period for recovery was 17 days (February). Greig considers that temperature has a powerful influence on the vitality of the cholera vibrio outside the human body.

Zlatogoroff (1911) observed 28 samples of cholera stools in bottles, one set kept at 16° to 18° C. the other at 3° to 8° C. From material in frequently opened bottles at 16° to 18° C. he recovered the vibrio up to 47 days, and from the set kept at from 3° to 8° C. up to 78 days. In other bottles kept hermetically sealed and only opened once, the vibrios lived for 6½ months at 16° to 18° C., and for 7 months at 3° to 8° C. (3).

Fomites.

Infected bedding and clothing, if kept moist, will retain the vibrios alive for considerable periods. They have been observed experimentally to survive for more than 200 days on an infected damp cloth kept in a closed chest. If the material was dried before being put away the vibrios did not survive more than 36 days (4). It would appear from this that under ordinary conditions only freshly contaminated fomites are likely to convey infection for any extended period. Damp freshly-stained linen favours survival, and laundry workers are thus liable to be infected during outbreaks. Pronounced liability to infection has in fact been noted amongst laundry workers in times of cholera prevalence.

Foodstuffs.

Fruits and vegetables, if contaminated, may act as conveying media for cholera. Pollak (1912) found that oranges, lemons, apples, and lettuce retained the vibrios alive after experimental contamination for periods extending from a week in the case of oranges to nearly a month in the case of lettuce (5). Survival depends on the retention of moisture and the rate of putrefaction.

An outbreak of cholera on a vessel is related by Simpson to have been traced to milk adulterated with water from a tank polluted by cholera dejecta (4).

Heiser has ascribed much importance to the handling of foodstuffs and of the leaves in which betel nut is wrapped for chewing as a source of infection in the outbreaks which occurred in Manila during the earlier periods of American occupation (6).

Dust and Earth.

There is considerable evidence, experimental and epidemiological, to show that cholera is not a dust-borne disease, and that the vibrio dies quickly when deposited upon or in the soil under natural conditions. Gross pollution by specifically infected fæces carries, of course, an obvious risk of transference of infective material on boots, clothing, or skin; but the prominent part formerly ascribed to polluted earth is no longer a practical factor in epidemiological procedure.

Insects.

Barber (7) has shown experimentally that cockroaches fed on human cholera fæces may harbor vibrios in their intestines, and may excrete them in large numbers for at least two days, and in smaller numbers for some 79 hours. Cholera vibrios from the fæces of infected cockroaches were found to survive on human food for at least 16 hours after discharge. Cholera vibrios were also found in the bodies of ants some 8 hours after ingesting cholera fæces.

Howard (1912) quotes instances of the isolation of cholera vibrios from flies taken in infected houses, of their isolation from the fæces of flies fed on cholera cultures, of their isolation from flies taken in a *post-mortem* room where cholera corpses had been examined, and of their recovery from the feet of flies seventeen hours after these had been experimentally contaminated (8).

Greig (1913) recovered cholera vibrios from the appendages and alimentary tract of flies in connexion with a carrier-caused outbreak in Puri Gaol (9).

In Natural Fresh Water.

The ability of the cholera vibrio to persist in fresh water has been frequently demonstrated, both experimentally and in the field. The Hooghly water at Calcutta is stated by Rogers to contain it frequently. Some other natural waters, and, according to Hankin, the Jumna at Agra, appear to be unfavorable to its survival.

The classical modern instance of water-borne spread of cholera is afforded by the outbreak in Hamburg in 1892, wherein no solitary link was wanting in the chain of evidence.

It may be here pointed out that, although the specific infection of a common water supply is practically the sole cause which has operated to produce those huge outbreaks in cities or towns with which cholera is usually associated in contemporary popular history, water-borne infection must not be allowed to overshadow the importance of other and more common modes of transmission. Careful observation of comparatively recent outbreaks in Naples, Constantinople, Tunis, and Bulgaria enabled the water supply to be excluded as a source of infection (11).

In Domestic and Impounded Waters.

Water-borne outbreaks on deep-water ships are rare at the present day, as care is usually taken to obtain supplies from safe sources.

Zirolia, working at Port Said in 1905, examined 384 samples of drinking water from ships, and found vibrios in 82 cases. In six of these the vibrios agglutinated with high dilution of cholera horse serum, standard 1 in 3,000. The origins of the water were respectively—Glasgow, Swansea, Colombo, Karachi, Alexandria, and Constantinople. These vessels were not associated with cholera outbreaks, and the morphology of the vibrios in four instances was different from that of the cholera vibrio (12).

An outbreak possessing certain special points of interest is recorded as having occurred amongst French warships at Toulon. These vessels were fitted with three separate water systems for drinking, washing, and boiler purposes respectively. The drinking supply proper was not infected, but the others were, and human infection had arisen either during ablution or through use of the washing supply for drinking. The source of infection was traced to an infected shore supply, and multiplication of the organisms was found to have occurred in the cisterns and pipes on board, and in the floating tanks in which the water was rafted off to the ships (13).

Schobl found in Manila that cholera vibrios added experimentally to tap water in the medium of fresh stools could be recovered up to the 56th day. In sterile water the organisms died out in seven days (14).

Instances of the spread of cholera by infected water supplies are frequent in the literature from 1849 onwards. The celebrated cases of the Broad-street pump in 1854, and of the rival water supplies in South London in the same year are classical instances which need not be here detailed.

In this connexion reference may be made to an interesting occurrence recently recorded by Greig. Cholera vibrios, accompanied by a cholera-like strain of vibrio, were recovered from samples of the filtered water drawn from the Tallah Reservoir, a portion of the Calcutta water supply. On investigation it appeared that the cholera vibrios were present in some and not in others of samples taken simultaneously, and did not appear in samples taken from other parts of the supply system. No evidences of epidemic incidence of cholera, or even of an increase of cholera cases, existed in the area supplied. The man who collected the samples was examined. The cholera vibrio was recovered from his stools, and a cholera-like vibrio was cultivated from his hands. He gave a history of having suffered as a boy 37 years before from a disease resembling cholera. He was taken off the duty of sample collecting, and the vibrios disappeared from the water samples (15).

In Sea Water.

The cholera vibrio appears to survive for considerable periods in sea water Schobl recovered it experimentally up to 106 days from sterile sea water kept at from 25° to 27° C. (16). Jacobsen recovered vibrios from a sample of harbor water 47 days after adding a culture (17). Zammit (1913) obtained on two occasions from the salt water of a bay into which cholera-contaminated material was delivered, abundant cultures of a vibrio indistinguishable from cholera; subsequent samples were, however, negative (18). Defressine and Cazeneuve (1913) found cholera vibrios in the mud and slime of the river at Toulon six months after a cholera outbreak had ceased (19).

The Technical Committee of the Paris Convention of 1912 states as follows :—" It is constantly demonstrated, particularly by experiments made at Copenhagen, that the organism " (*i.e.*, cholera vibrios) " may, under certain circumstances, remain alive during several weeks in water which has a very high chlorine content. . . . Water ballast discharged in healthy ports may be suspected as being capable of spreading cholera infection if it comes from contaminated ports " (20).

De Vogel (1913) has pointed out a practical risk of infection which arises from the discharge of deck scuppers or closet pipes whilst boats or lighters are lying alongside a vessel (21).

Contact Infection.

The influence of contact infection, particularly in congested quarters ashore or afloat, is a very important factor in cholera outbreaks. Jatta (1912) considers that 90 per cent. of the cases in the Naples outbreak of 1911 were due to infection through communication with patient or carriers. Even in cases where infection was traced to contaminated food the presence of a case or a carrier in connexion with food supply or food preparation was nearly always demonstrated (22).

Eckert (1913) states that water infection did not appear to play any part in a large outbreak in the Bulgarian Army during the Balkan war, but the infection arose from neglect to use latrines, contaminated ground, and hands infected from contaminated shoes, clothing, &c. (23). Kraus considered that water was implicated to some extent, but admitted that in the hospitals for the wounded, where the water factor could be excluded, sporadic cases were constantly occurring.

Conseil (1912) considered that the great majority of cases at Tunis and its neighbourhood in 1911 were due to direct contact with the sick or with carriers, a mode of spread favoured by the habits of the people. Water infection took scarcely any share in the epidemic (24).

Simond and Vallery-Radot (1914) state that water could be excluded as a source of infection in two considerable outbreaks of cholera at Constantinople and its environs in 1910, 1911, and 1912. They describe the disease as essentially associated with dirty hands (25).

Hehir (1913) quotes a case of a newly appointed sanitary inspector in an Indian district, to whom the characters of rice-water stools were being demonstrated during an outbreak. The man stated that he had been passing similar stools for two days, and 24 hours afterwards was dead of cholera (26).

Heiser records that of 876 contacts examined in Manila in connexion with 70 cases, 40 showed the presence of vibrios of some sort, and 29 of Koch's vibrio (27).

The place of the cholera-carrier as a conveying agency will be dealt with in the next chapter.

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VI. CHOLERA CARRIERS.

Classification of Carriers.

For purposes of practical epidemiology cholera carriers may be divided into three groups :—

(1) Those who excrete vibrios for a longer or shorter period after known or suspected infection with cholera.

(2) Those who excrete vibrios after having been in known or suspected association with cases of cholera or cholera-infected material, but who are, themselves, in apparently good health.

(3) Those who excrete vibrios, but in respect of whom no definite history of infection or association is available.

Carriers and Maritime Quarantine.

The relative position of the carrier in respect of prophylactic activities against cholera under a system of maritime quarantine has been expressed by Craster (1) in terms which are as applicable to Australia as to America. " . . . . even with the strictest precautions against infection at ports of departure, the distance from an infected locality is no safeguard against sea-borne cases of cholera. . . . The real danger to the public is not alone the person sick with the disease, but also the person infected with the specific organism and presenting no apparent symptom of illness . . . ."

Carriers and Shore Outbreaks.

Munson (2), in discussing the measures which were applied successfully to the Manila outbreak of 1914, regards actual cases as symptomatic of a wider-spread and a more dangerous concealed infection. He found that carriers were not only the most numerous sources of infection, but the most insidious, and lays down the axiom that prompt eradication of a cholera outbreak requires the detection and isolation of carriers as a scientific prerequisite.

Channels of Excretion of Vibrios from Carriers and Convalescents.

The principal and obvious channel of vibrio excretion is the intestine. Greig (1913) has shown, however, that the urine of 8 out of 55 cases of cholera examined by him contained the specific vibrio (3). He also found large numbers of the organisms in consolidated areas of the lung in a case which died from pneumonia and nephritis thirteen days after recovery from acute cholera, the vibrios lying free, chiefly between cells in the cellular exudate in the alveoli.

Period of Vibrio Excretion in Convalescents.

Ledingham and Arkwright conclude from the examination of a large number of recorded observations that about half of the persons who recover from a definite attack of cholera retain the vibrios in the intestinal discharges for from ten days to a fortnight, whilst only 5 or 6 per cent. remain infective for over 25 days ; but that amongst these latter 1 or 2 per cent. continue to excrete the bacillus intermittently for two or three months (4).

Rosenau states that the vibrios usually disappear from the faeces of cholera convalescents between the fourth and fourteenth days (5). He quotes the following as longest observed periods of persistence in stools of convalescents or bacillus carriers, collated by Pfeiffer from the records of various observers :—

Observer.	Longest duration (days).
Guttman	10
Lazarus and Pulicke	12
Michailow	12
Pfeiffer	13
Abel and Clausen	15
Simonds	18
Rumpel	24
Rommelaere	47
Kolle	48
Donitz	49
Burgers	69

Schobl records the following periods of persistence of cholera vibrios in the stools of 78 cases and convalescents observed by him during the Manila outbreak in 1914 (6) :—

Stools, positive (days.)	Number of Persons.
2–7	43
7–14	22
14–21	6
21–28	5
48	1

Kulescha records the case of a man who fell ill with cholera in November, 1908, became a carrier with vibrio-positive faeces for 57 days after recovery, and died in September, 1909 (7.) Cholera vibrios were recovered from the bile passages, but not from the intestine.

The second and third classes of carriers ("healthy carriers") are obviously difficult to dissociate accurately from those who develop their condition as a consequence of a mild infection. Ledingham and Arkwright conclude that "probably nearly all have had slight symptoms at some time" (8). It is clear from many recorded investigations, however, that a residue of cholera carriers experience no noticeable antecedent disturbance of health.

Jatta (1914) records that during the 1911 outbreak at Naples 10 per cent. of all healthy contacts examined were found to carry the vibrio (9). The proportion varied greatly in different groups. The organisms were equally virulent with those from the actual cases, but were present in smaller amount. The carriers usually stopped excreting vibrios in from three to five days, but 15 per cent. continued for from six to twelve days. If a carrier developed gastro-intestinal disturbance from some other cause, liability to an attack of cholera ensued.

McLaughlin (1910) found from 6 to 7 per cent. of cholera carriers amongst healthy individuals living in the infected neighbourhoods in Manila in 1908 (10).

Greig (1913) found that 6 out of 27 persons in close contact with cholera cases were excreting cholera vibrios in their stools, although apparently healthy. Discharge was very intermittent (11).

Defressine and Cazeneuve found 44 per cent. of healthy carriers amongst sailors in vessels where cases had occurred. The number of germs was small, and the duration of the carrier stage not over eight days from discovery (12).

Sergent and Negre found amongst 67 pilgrims returning from Mecca two who harboured vibrios, of which the specificity was determined by Pfeiffer's reaction and agglutination tests (13).

At New York between 20th July and 16th November, 1911, 26,455 passengers were examined bacteriologically for cholera vibrios, and 26 were proved to be carriers. These were selected passengers who had before departure been submitted to the following procedure :—

> " With the co-operation of the Italian Government, all persons from the Levant contemplating departure for the United States have been, as a precaution against cholera, held in a detention home at Naples for a period of five days, then bathed, their effects disinfected, all foodstuffs confiscated, and bacteriological examination made to exclude carriers " (15).

Simond and Vallery-Radot (1914) state that 2,269 contacts examined during cholera outbreaks in Constantinople and its environs yielded 63 carriers (16).

Of 1,242 Filipino labourers examined at Honolulu in 1913 on arrival from the Philippines 2 were found to be carriers (15).

Vibrios in the Gall Bladder.

Greig (1913) examined the bile of 271 fatal cases of cholera, and cultivated the specific vibrio from 80 of these. He found distinct pathological changes, macroscopic and microscopic, in the gall bladders of 12 of the 80 positive cases, and points out that an apparently healthy convalescent or contact harbouring cholera vibrios in the gall bladder forms an obviously dangerous reservoir of infection (17). His observations on the recovery of vibrios from the urine and from consolidated lung areas of cholera cases have already been referred to (18).

Schobl records cholera-positive results in 17 cases out of 39 examinations of gall bladders in cholera cadavers at Manila. In all cases the vibrio was present in the intestine. Only three gall bladders showed macroscopic lesions (19).

Kulescha records having found vibrios in 46 per cent. of 109 gall bladders from cholera cadavers, and 10 per cent. of cholecystitis amongst 430 cholera cadavers, mostly in the first or second week of the disease (20).

Hunter (1914) records that at Singapore he recovered cholera vibrios from 31 out of 104 gall bladders from fatal cases of cholera. He also recovered the vibrio in pure culture from the liver of a fœtus in utero (21).

Deferred Attack amongst Carriers.

Munson records the following instances of deferred invasion in cholera carriers (22). During the search for carriers in Bilibid Prison, Manila, during 1914, three convicts were reported as positive carriers on 10th and 11th September. They were isolated, and examined bacteriologically every day, being found continuously positive for cholera. Two developed true cholera on 27th September, after having been carriers for sixteen and seventeen days respectively, and the third developed cholera on 29th September, and died of it in eight hours. As Munson points out, this man " might have travelled half-way round the world scattering his infection broadcast during his eighteen-day period as a carrier, and died of true cholera in a place many thousands of miles from any other source of infection. There is a warning in such cases that health officers all over the world would do well to heed."

OUTBREAKS TRACED TO CARRIERS.

The following are illustrative examples of recorded instances in which outbreaks of cholera have been traced to carriers :—

An Indian native developed cholera on 6th July, 1912, was treated in a cholera hospital, and discharged cured on 13th July. On 23rd July he was sent to Puri Gaol. Cases began to develop a few days after his arrival, until 17 had occurred, with 5 deaths, in a gaol population of 222. On 28th July he was found to be excreting cholera vibrios in large quantities (23).

In July, 1909, an outbreak of cholera occurred at the European Hospital, Calcutta, and nine nurses were attacked in 30 hours. Haffkine and Clemesha identified comma bacilli in water vessels and milk, and examined washings taken from the hands of native servants. Two of the kitchen servants, apparently in good health, yielded vibrios under this treatment, and on examination of their stools were found to be excreting morphologically typical cholera (24).

At Bilibid Gaol, Manila, in 1906, cholera broke out in spite of rigid sanitary control of the food and water supplies. To ascertain if bacillus carriers were a contributing factor the stools of those prisoners who were concerned in the handling of the food and water were examined. In 17 out of 264 persons cholera vibrios were found to be present. Orders were issued for the disinfection of the hands upon leaving the latrine and before eating, and the outbreak ceased. It did not reappear in the prison, although cholera was prevalent in the surrounding district (25).

Doty (1911) records a case of much practical significance in quarantine work. A vessel arrived at New York from Naples ; no cases of cholera or diarrhœa had occurred during the voyage. On the third day after landing a passenger developed cholera and died. As no other recognisable source of infection existed the case was apparently due either to infection from an unrecognised carrier on board, or was himself a *porteur précoce* (26).

TREATMENT OF THE CARRIER CONDITION.

Treatment designed to free cholera carriers of their vibrios has, as yet, been unsuccessful in practice. Salol in doses of ·6 grm. twice daily was tried in Manila, but without avail, and numerous other drugs have given similarly negative results. The following treatment is stated by Kalberlah to have given good results in cleansing the fæces of typhoid carriers, and might be worthy of trial in cholera. Seven to fifteen drops of tincture of iodine are given from three to five times daily in a glass of water, half-an-hour after food, with teaspoonful doses of blood charcoal three or four times daily (27).

Successful results are claimed to have been obtained with healthy carriers by treatment with kaolin and charcoal. A dosage of 125 grammes of very finely pulverized kaolin stirred into half a tumbler of water and repeated in three hours is stated to be well tolerated. Wolff Eisner administers a double spoonful each of kaolin and charcoal, from one to three times daily (28).

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VII. THE PROPHYLAXIS AND CONTROL OF CHOLERA.

In Greig's words: "The problem of the prevention of cholera, shortly stated, is the protection of mankind from man" (1). The Technical Sub-Committee on Cholera of the Paris Convention, 1912, declared: "The virus of cholera is contained in human excreta. Man himself is the principal agent in its diffusion" (2).

Personal prophylaxis is principally a matter of scrupulous and intelligent cleanliness. The classical four F's—Food, Flies, Fingers, and Filth—under which American sanitarians have summed up much valuable popular teaching in connexion with the reduction of typhoid fever, applies also to cholera. The epidemiology of cholera from the preventive stand-point is, in fact, closely similar to that of typhoid fever.

PROPHYLACTIC INOCULATIONS.

Prophylactic injections of cholera bacilli have been used on a considerable scale as a means of securing artificial immunity. The immunity conferred by an actual attack of cholera is said to be of short duration.

The first attempts in this direction were made by Ferran, in Spain, but his technique was defective, accidents occurred, and the work was suppressed by Government.

HAFFKINE'S METHOD.

Haffkine, in India, attacked the problem on the general lines followed by Pasteur in respect of anthrax, using at first two vital vaccines of different strengths (3). By 1895 he had inoculated some 43,000 persons without any bad result, and considerable evidence had accumulated in favour of the method. Haffkine later abandoned the preliminary attenuated virus, and used a suspension of a live virus which had been brought to a uniform and stable degree of virulence by successive graduated passages through guinea pigs. The immunity conferred is not quite complete, and is said to last for some fourteen months, after which reinoculation is necessary. The somewhat severe reaction has probably prevented the more extended use of this method.

Amongst compared populations of tea garden coolies in Assam numbering 12,327 persons in all, 6,549 non-inoculated yielded 198 cases, with 124 deaths, whilst 5,778 inoculated by Haffkine's method yielded only 27 cases, with 14 deaths. Two outbreaks in Bengal gaols were dealt with experimentally by inoculating by Haffkine's method as nearly as possible half the inmates, without any selection. The death rate amongst the inoculated amounted to only one half and one quarter respectively of those amongst the uninoculated (4).

KOLLE'S METHOD.

A vaccine introduced by Kolle is claimed by Haffkine to be a modified devitalized vaccine which had been originally devised by him, and which was rejected in favour of his later method (5). It has been used on a considerable scale. The method of preparation of Kolle's vaccine for use in Greece in 1913 was as follows (6):—

A recently isolated virulent strain of proved type (including agglutinating and completement fixing powers) is passaged through guinea pigs to raise, and keep raised, its virulence. An agar culture of this passaged vibrio is emulsified in physiological saline so that 1 c.c. = 4 mg. vibrios. It is killed at 50° C., and 0·5 per cent. phenol added. Dosage was 0·1 c.c. under 1 year of age; 0·2 c.c. for 1 to 3 years, 0·3 c.c. for 3 to 5 years, and 0·5 c.c. for over 10 years. A second dose of double the amount was given after eight days. All persons with raised temperature or serious heart or kidney mischief were exempted.

Savas (1914) states that inoculation did not interfere with the fighting value of troops. The results obtained in eleven army divisions were as follows:—

Of 14,613 inoculated once, 4·2 per cent. developed cholera.
Of 91,224 inoculated twice, 0·7 per cent. developed cholera.
Of 8,968 not inoculated, 9·3 per cent. developed cholera.

Amongst the anti-cholera ambulance and hospital staffs at Salonika the following results were recorded:—

Of 433 inoculated once, 12·2 per cent. developed cholera.
Of 376 inoculated twice, 10·2 per cent. developed cholera.
Of 1,113 not inoculated, 27·5 per cent. developed cholera.

In Hiogo, Japan, during 1902, 77,907 persons inoculated are reported to have yielded 47 cases (·06 per cent.) and 20 deaths, whilst 825,287 non-inoculated yielded 1,152 cases (0·13 per cent.), with 863 deaths. No persons who received the second injection of 4 milligrammes contracted the disease (7).

Arnaud (1914) states that in the Greek army during the second Balkan War, 72,652 soldiers received two inoculations of Kolle's vaccine, and yielded a case incidence of 0·43 per cent; 21,216 received one inoculation, and yielded 3·12 per cent. of cases; and 14,332 were not inoculated, and yielded 5·75 per cent. of cases (8). Moustouses states that the uninoculated in the Greco-Bulgarian War showed a case-mortality of 34 per cent., as against 20 per cent. in those twice inoculated (9).

Nijland (1913) records that in a convict quarter at Glodok 45 persons out of 2,400 contracted cholera in 1911, when inoculation was imperfectly performed; but in 1912, after thorough inoculation, only two cases occurred, although the disease was equally prevalent in the two years amongs the general community. He also states that 8,000 inoculated Europeans at Batavia yielded only three cases of cholera, one of which developed two days after inoculation, whilst amongst 2,700 non-inoculated 32 cases occurred, with 15 deaths (10).

Strong's Method.

Strong, working in the Philippines, sought to neutralize the intracellular toxins which produce the severe reaction in Haffkine's method. The process has not, apparently, received a full trial in the field. A 24-hours broth culture is sprayed over agar in large flat flasks, which are then incubated at 37° for twenty hours. The subsequent growth is suspended in sterile water, heated to 60° C. for from 1 to 24 hours, incubated at 37° C. for from 2 to 5 days, and filtered. The filtrate is tested for sterility. A dose of 2 c.c. is used, being the equivalent of 10,000 rabbit units of immunity (11).

The general technique of prophylactic injection against cholera is similar to that required for antityphoid inoculation, and postulates merely the introduction of the prophylactic material to the subcutaneous tissue without extraneous contamination. The usual precautions require to be taken against accidental intravenous injection, and against contamination from the skin or otherwise. Dosage will be determined by the manufacturing laboratory. The acquired immunity sets in after a few days, but does not confer absolute safety from infection in all cases.

PERSONAL AND GENERAL PROPHYLAXIS BY ATTENDANTS ON CHOLERA CASES.

The large volume of fæces and vomit from an acute case and the forcible manner in which these are apt to be discharged without warning render it exceedingly difficult to guard against contamination of the clothing and persons of attendants, unless special precautions are taken.

Effective disinfection is of extreme importance in the control of cholera, and all attendants on cases should be carefully instructed in the precise detail to be followed. Carelessness or forgetfulness in this particular are nowhere more out of place than in a cholera ward. Gowns or overalls and caps fully covering the hair should be worn by all who attend on the patient. These should be removed on leaving the ward, and hung up ready for use near the ward door. When dealing with acute cases, goloshes or rubber boots and a full waterproof apron will be required to prevent contamination of clothing.

Garments which become contaminated, however slightly, by cholera discharges should be immersed at once in a 2½ per cent. solution of an effective cresol disinfectant, and replaced by clean ones. A liberal supply of overalls and gowns should be immediately available for ward use. The use of rubber gloves by nurses in all operations involving the handling of the patient or of infective material is a desirable safeguard. These gloves should be disinfected by sterilization in an autoclave after each occasion of use. After such sterilization they are then well covered with Franch chalk (previously sterilized by dry heat) and wrapped in dry sterilized towels. These should be placed in covered enamel containers, and kept until required for use.

Particular care should be exercised in disinfecting the hands after all dealings with cholera. Even where gloves are used it is advisable to do this as a further measure of safety. A liberal use of a good cresol soap, applied with a nail-brush and hot water, followed by immersion of the hands for a few seconds in methylated spirit will effect the purpose.

No food should be taken during actual hours of duty in attendance on cholera patients, but care should be taken that attendants should not be allowed to go on duty fasting, and that light digestible food is available should they desire it after coming off duty.

Purgatives of any kind should not be taken by those in attendance on cholera cases except under medical direction.

Indigestible foods, excessive fatigue, or other agencies which tend to lower resistance to infection should be avoided.

If reliable material is available for anti-cholera inoculation the staff of a cholera hospital should receive its protection, provided that the period of active reaction and coincident lowered resistance is not passed in actual attendance on patients or in dealing with infected material. It should be made clear that protection so conferred will not justify relaxation of the most minute precautions in respect of personal and general prophylaxis.

Close medical attention should be given at once to gastric disturbances and diarrhœa amongst those connected in any way with cases or infected material. Effective measures should be taken to guard against development of carriers amongst the staff, and to enforce necessary precautions if such are found. Periodic bacteriological examination of the hands and finger nails of all attendants will form a useful line of investigation, and will serve incidentally to emphasize instructions regarding scrupulous precautions against self infection.

A liberal supply of an approved disinfectant solution should be kept constantly at hand in cholera wards and freely used.

The possible conveyance of infected material by flies, ants, cockroaches, and other insects, or even by animals under certain conditions requires to be guarded against.

Release of patients, contacts, and resident staff must be conditioned entirely by bacteriological examination of fæces. Nothing less than three vibrio-negative examinations on three successive days should be accepted.

BEDSIDE DISINFECTION OF CHOLERA DISCHARGES.

A 5 per cent. solution of a cresol disinfectant with a coefficient of at least 10, well mixed with an equal volume of cholera discharges will effect absolute disinfection in one hour.

A mixture containing 1 lb. of fresh chlorinated lime in 4 gallons of water, well mixed with an equal volume of cholera discharges will similarly effect absolute disinfection in one hour. Chlorinated lime is, however, apt to be unreliable in respect of its available chlorine content.

In either case the receptacle should be securely covered against flies, and left before emptying, for the indicated period of one hour at least.

Bed clothing and other material contaminated with discharges from a cholera case should be immersed for an hour in 2½ per cent. solution of a cresol disinfectant solution before being sent out. When released from the ward it should go out thoroughly wet with the cresol solution.

All ward food utensils should be thoroughly disinfected by boiling after each occasion of use.

Thermometers should be immersed after use in a dish containing 2½ per cent. cresol disinfectant solution.

Floors, walls, &c., which have been contaminated with cholera discharge should be well mopped down with 2½ per cent. cresol disinfectant solution.

Bed pans, sputum cups, and urine bottles should be thoroughly treated with 2½-per-cent. cresol disinfectant solution, inside and out and scalded before they are returned to use.

All discharges, including sputum, urine, and vomit, as well as fæces, must be regarded as potentially infective.

MANAGEMENT OF CHOLERA OUTBREAKS ON SHIP-BOARD.

Cholera outbreaks on board ship usually, but not invariably, show a tendency to be limited to one class or department. This is illustrated by the case of the *Dorunda* described in the first chapter. Water-borne outbreaks on ships display the ordinary explosive character of water-borne outbreaks on shore, and are liable to invade all classes which consume the infected water in a raw state. The general mode of spread is by personal contact in cramped quarters, or, less frequently, by food contamination. The possibilities, however, are governed only by the unconscious opportunities of the human distributing reservoirs on board.

The immediate technique for control of a ship-board outbreak where a sufficiently well-equipped quarantine station is available, resolves itself under five headings :—

(1) Landing and isolating all known or suspected cases.
(2) Landing and isolating separately, for bacteriological and clinical observation, all known or suspected carriers, and all intimate contacts of cases.
(3) Landing in quarantine for separate bacteriological investigation all other persons in order to locate carriers.
(4) Disinfecting all known or suspected infected material on board.
(5) Sorting out the *personnel* further, as indicated by the bacteriological findings.

The recorded instances of intermittent carriers and deferred invasion will indicate the need for extreme caution in considering applications for surveillance release even after negative bacteriological examination.

If an available quarantine station is not fully equipped for the necessary separation and accommodation, actual cases and other obvious sources of danger may be landed in isolation, and any practicable steps taken for the protection of those remaining on board. The precise nature of such action will necessarily be governed by circumstances, the object being to remove the human reservoirs of the disease and to render harmless any extra-corporeal source of infection on board. The vessel can then be sent on to the nearest port equipped with a station capable of dealing fully with the condition.

If no quarantine station is available, all practicable steps should be taken to isolate effectively on board any known or suspected cases or carriers in order to prevent spread of infection. Any necessary instructions having been given in writing to the master regarding the specific steps to be taken, the vessel can then be sent for further action to the nearest port equipped with a quarantine station.

In any case the Chief Quarantine Officer must be kept fully advised of action taken or contemplated.

MANAGEMENT OF CHOLERA OUTBREAKS ON SHORE.

Control of a cholera outbreak on shore would necessitate the following principal measures :—

A.—Immediate Action.

(1) Location as rapidly as possible of all cases, suspected cases, and contacts.

(2) Segregation of cases under conditions which will prevent them from acting as foci of infection.

Pending actual removal of cases, steps should be taken to secure effective bedside disinfection, and to prevent dissemination of infection outside the premises.

(3) Segregation of contacts pending bacteriological investigation for carriers amongst them. Until full bacteriological investigation has been made, each domestic contact should be regarded as a potential carrier.

(4) Location and disinfection of infected and possibly infected materials including discharges, fomites, &c.

(5) Inquiry into any apparent source of origin of the outbreak, and into its development so far as can be ascertained without undue delay, with a view to the practical and immediate application of emergency safeguards at any point of special danger.

(6) Early and full transmission of available information to the central sanitary authority, and report under the Quarantine Regulations to the Chief Quarantine Officer.

The carrier and the "missed case" are the most potent of all factors in carrying on a sporadic outbreak to epidemic intensity, and until this chain is broken the outbreak cannot be regarded as safely in hand.

B.—Action pending Assistance.

The foregoing lines of action—Nos. 1 to 5—would be developed as opportunity offers and requires. In addition, the following further action should receive attention as opportunity offers :—

(7) Flying survey of the infected area, with a view to delimiting the probable points of most danger, and extending emergency measures to cover these.

(8) Enlistment of the active co-operation and support of the local medical profession, the local sanitary authority, and local hospital authority.

(9) Utilization of any available bacteriological facilities for the provisional investigation of carriers, missed, or mild cases, &c.

(10) Organization of house to house inquiry through the infected areas for the detection of concealed, mild, or suspected cases, and for contacts who have not been already segregated.

(11) Investigation of all recent deaths, and arrangements, where possible, for *post-mortem* examination of suspicious deaths occurring since the apparent date on which the outbreak began.

(12) Collection and transmission of suspected material for bacteriological examination.

(13) Collection and transmission to the central sanitary authority of any information concerning outward travellers from the infected area, which appears likely to be of service in preventing or limiting spread of infection.

(14) Any immediately practical measures for diminishing risk from existing methods of collection, removal, or disposal of human excreta (including privies, fly prevalence, &c.).

(15) Development of emergency measures for safeguarding the public water supply, including close investigation into the health and recent movements of all persons employed thereon, and their households.

C.—Ultimate Action.

When assistance is fully available, the following scheme of organization would be indicated in addition to development of the foregoing, as occasion requires :—

(16) Organization of an adequately trained staff equipped with all necessary legal powers, and provided with requisite material, &c.

(17) Organization of arrangements for prompt and accurate collection and recording, and use of all necessary information relating to the outbreak.

(18) Organization for the prompt and effective accommodation of cases in special isolation hospitals.

(19) Systematic bacteriological search for carriers (including mild, atypical, and missed cases), both in connexion with diagnosed or suspected cases and otherwise.

(20) Full laboratory assistance for the detection of carriers, if necessary on a considerable scale, and for the examination as required of material from cases, cadavers, carriers, and others.

(21) Effective segregation of all proven or suspected carriers in a special establishment.

(22) Supervisory control of foods and drinks liable to convey cholera, and examination of all persons selling or preparing such articles, in order to detect possible carriers amongst them.

(23) Arrangements for effective disinfection on the scale required by the epidemic condition.

(24) Surveillance or other requisite control of outward travellers from the infected area.

(25) Control and application of the whole organization by a skilled epidemiologist, whose experience will enable him to take necessary action for detecting and dealing with special or general developments.

ACTION BY MEDICAL PRACTITIONERS IN CASES OF SUSPECTED CHOLERA.

The marked tendency which cholera displays for spreading by personal contact, and for creating carriers amongst the personal entourage of the patient, together with the obscurity which may veil the true character of atypical cases, renders it very necessary that in times of epidemic prompt action should be taken to limit possible infection until the true nature of any doubtful condition is cleared up by bacteriological investigation. All discharges from the patient should be carefully and effectively disinfected by mixing and soaking (if on fabrics) with at least an equal volume of a 2½-per-cent. solution of a good cresol disinfectant, and allowing to stand for several hours before they are disposed of. Those in attendance on the patient should be warned of the necessity for scrupulous care in cleansing their hands and all utensils used in the sick room. The patient should be closely isolated

A specimen of the fæcal discharge should be secured for examination, in the manner indicated on page 19, and the case reported to the proper authority without delay. It is of considerable practical importance that all persons who have been in contact with the patient since the beginning of illness should be located, as it is amongst these persons that carriers are most likely to be found.

INVESTIGATION OF NIGHTSOIL SERVICES.

When investigating conservancy nightsoil services in connexion with cholera measures, particular attention should be paid to the following details :—

(1) Health of employees and their families, and the detection of possible carriers amongst them.

(2) Whether pans are fitted with proper covers or otherwise protected from access by flies during removal to the disposal area. In emergency, temporary covers may be improvised from bagging wetted with a strong cresol disinfectant solution, or even with kerosene.

(3) Whether pans are removed and replaced by clean ones in all cases (double service). The practice of "boxing" (*i.e.*, emptying several partially full pans into one for removal in order to save cart space) is familiar to most sanitary contractors, and should be watched for.

(4) A "single service" system should be altered to "double service" and care should be taken to ensure that pans are cleaned before they are replaced.

(5) All carts should be thoroughly cleansed.

(6) Trenches should be examined for fly-breeding. If this is found, they should be liberally treated with borax to kill larvæ. Three-quarters of a pound of borax dissolved in 2 gallons of water and applied with a coarse spray or watering can will effect the purpose. If filled-in trenches are found to be acting as fly-breeding places and borax is not available, they may be burned over with brushwood, or treated liberally with kerosene and soapsuds to kill pupæ in the surface layers. It must be recollected that fly larvæ can ascend through a considerable thickness of loose soil to pupate.

(7) Wherever possible, earth disposal should be replaced by a system of boiling or incinerating. A 400-gallon iron tank set over a "trench furnace" on the principal of a military field kitchen will serve to sterilize considerable quantities of nightsoil. For a large service several tanks may be necessary. From 70 to 100 gallons of a 5-per-cent. solution of any good cresol disinfectant should be placed in the tank and brought to boil. The pan contents are turned into this, together with all pan washings. Incineration can also be effected in a mud-furnace by the aid of some tar and small fuel, assisted by a good draught.

(8) The contents of closet-pans should be treated regularly with kerosene or kerosene and soapsuds to repel flies and to kill larvæ. Careful attention should be given to the proper construction and sanitary management of domestic privies.

EMERGENCY MEASURES FOR WATER SUPPLIES.

A cholera outbreak may necessitate emergency measures for the protection or sterilization of water supplies. Reference has already been made to the advisability of examining employees and residents on water works and collecting areas with a view to the detection of any cases or carriers amongst them. Chemical analysis of waters need not be considered in an emergency of this nature, except for the purpose of estimating the organic matter present in connexion with chlorine treatment, owing to the obvious fact that several tons of crude sewage may be added to each million gallons of any reasonably good water without affording any conclusive chemical evidence of contamination. Bacteriological results are readily vitiated by any delay between collection and examination. Careful examination of the physical and topographical features of the supply area and distributing facilities, aided, if necessary, by the use of fluorescin, salt, or other agency for tracing possible lines of contaminating soakage, will afford the most useful index for the application of measures.

If the supply is drawn from surface wells, these should be examined individually, all risky ones closed and treated with a chlorine process or permanganate of potash, 2 grains to the gallon (12), and the sources of supply limited to a few which can be treated as required, and kept under close supervision.

Boiling is the simplest and best safeguard for domestic supplies, and the necessity for it should be emphasized by notices and verbal warnings in the affected areas. Warning should also be given that practically all domestic filters are untrustworthy, and that most are merely water-soiling devices.

The best available method for large scale emergency disinfection of public water supplies is afforded by one or other of the chlorine processes. The materials are not difficult to obtain, and the process is chemically and mechanically simple in its application.

The following methods have been used successfully :—

(1) Direct passage of the liquefied gas from cylinders. Chlorine liquefies at 6 atmospheres, and is stored for commercial use in cylinders of varying sizes up to several hundred pounds in weight. A convenient size recommended by Nesfield contains 10 lbs. of liquid chlorine, and weighs about 20 lbs. The gas is used in the proportion of from 1 in 175,000 to 1 in 350,000 (10 to 20 grains for each 50 gallons), according to the amount of organic matter present in the water. Muddy waters require to be rough filtered through two layers of blanket, or cleared with alum, 6 grains to the gallon, before treatment with chlorine. Nesfield (13) recommends regulating the outflow of gas by means of a brass nozzle screwed on to the cylinder, containing a fine bore glass thermometer tube of such length that the resistance it offers to the issuing gas allows only half-a-grain to escape per second. The gas may be passed into a few gallons of water and the latter used as a solution for adding to larger amounts, or may be added direct. The water is dechlorinated after ten minutes by a few crystals of hyposulphite of soda.

(2) For smaller supplies, as at hospitals or camps, the following process devised by Nelson (14) is convenient and effective :—

A 24-oz. wide-mouthed bottle is marked at its 20-oz. level, and provided with a close-fitting cork, bored for two pieces of glass tube about 0.5 cm. diameter. One piece of glass tube is fitted with a stopcock, and the end allowed to project an inch or so below the cork. The other piece of tube is bent at a right angle above, and led to within an inch of the bottom of the bottle. From the upper end of this tube a rubber tube of suitable diameter is led to a 1-oz. bottle, and carried a short distance through the tight-fitting cork. The latter bottle is marked at the 2-drachm level.

For use, the large bottle is filled with water to the 20-oz. mark, and the stopcock on the short tube is closed . Two drachms of concentrated hydrochloric acid are placed in the small bottle.

Three 5-grain potassium chlorate tabloids (15 grains in all) are powdered and added to the acid in the small bottle. The stopper is inserted at once, and the gas generated is allowed to pass over into the water in the large bottle. The small bottle may be shaken and warmed gently to promote action. The pressure in the large bottle is adjusted by the stopcock as required. The process occupies about fifteen minutes.

When all the available gas has come over and is dissolved, the acid in the small bottle is poured into the large one. The latter then contains a solution of chlorine and chlorine oxide, of which each ounce acting for 30 minutes in a clear water will sterilize 5 gallons.

If the water to be treated is turbid, it should be previously cleared with alum, 6 grains to the gallon.

The solution prepared as above indicated is stated to remain potent from three to four days, if kept in a well-stoppered bottle.

Nelson also describes a handy domestic device consisting of two 5-gallon tanks provided with taps fitted 2 inches from the bottom to avoid sediment, and removable covers (15). The upper one is used for clearing with alum, and the lower one for the addition to the cleared water of chlorine water prepared as above.

(3) Chlorine treatment of water may also be effected by the addition of calcium hypochlorite ("bleaching powder"). The precise dosage depends mainly on the amount of organic matter in the water, ranging from 0.2 parts per million calculated as chlorine (see below) for clear upland waters to 3 parts per million or more. Excess of hypochlorite leaves an unpleasant taste in the water but this excess can be neutralized by adding sodium hyposulphite in proper amount.

In emergency, the required amount of bleaching powder could be placed in several small cheese-cloth bags on a pole, and towed back and forth in a reservoir. At the end of half-an-hour the issuing water could be tested as hereunder for chlorine content.

An apparatus for adding measured quantities of solution of calcium hypochlorite to water at a main outlet or otherwise can be readily improvised from stout barrels and galvanized iron piping, painted with asphaltum or good mineral paint. A mixing tank of suitable capacity is provided at a higher level, with a draw-off recess in its bottom for sludge.

An ordinary closet flush-tank, or an improvised device on the same lines, enables the solution to be added in known quantity at known intervals.

If much organic matter is present in the water to be treated, precipitation with alum or rough filtration through two thicknesses of blanket may be attempted before the application of the hypochlorite solution. The amount of bleaching powder requires to be increased according to the amount of organic matter in the water.

The following data will enable quantities to be calculated :—

Bleaching powder of good quality should contain about 30 per cent. of available chlorine.

Twenty-seven ounces of "30-per-cent." bleaching powder added to 50 gallons of water will give 1 part of available chlorine to 1,000 parts of water. One gallon of this mixture added to 1,000 gallons of the water to be purified will give 1 part of available chlorine per million, 2 gallons will give 2 parts per million, and so on.

One pound of "30-per-cent." bleaching powder in 30 gallons of water will give 1 part of available chlorine to 1,000 parts of water.

To neutralize 1 part of chlorine per 1,000 parts of water requires the addition of 7 lbs. of sodium hyposulphite (the "hypo" used in photographic work) to every 100 gallons. Seven pounds of sodium hyposulphite will thus neutralize 1 part of chlorine per million in 100,000 gallons ; 14 lbs. will neutralize 2 parts of chlorine per million in 100,000 gallons ; and so on.

The amount of chlorine in commercial bleaching powder is apt to vary considerably, especially in old samples.

Quantitative determination of the amount of chlorine present in any given sample can be readily carried out. The process is as follows :—

Solutions of decinormal iodine (12.69 grammes to the litre) and of arsenious acid (4.95 grammes of pure arsenious oxide and 20 grammes of sodium bicarbonate to the litre) are employed.

One gramme of the substance to be tested is rubbed up with water in a mortar and made up to 100 c.c.

Ten c.c. of this turbid liquid, previously well shaken, are placed in a white porcelain dish. This contains 0.1 gramme of the test substance.

The arsenious acid solution is added to slight excess, as shown by the fact that when a little clear starch solution and a drop of potassium iodide solution are added to the test tube, or tried with a glass rod on paper a blue colour no longer appears.

Now add fresh starch solution, and run in the iodine solution until a faint blue tint remains permanent, after shaking the test tube.

The amount of the iodine solution used corresponds to the excess of arsenious acid added. Deduct this, in c.c., from the amount of arsenious acid solution used, also in c.c., and the difference represents the amount of arsenious solution which is oxidized by 0.1 gramme of the substance tested. Each 1 c.c. of the arsenious acid solution is equivalent to 0.00354 gramme of available chlorine contained in the 0.1 gramme used for the test.

One ounce avoirdupois is equivalent to 28.35 grammes, and 1 lb. (16 ozs.) is equivalent to 453.6 grammes. One gallon of water weighs 10 lbs., and is equivalent to 4.536 litres.

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APPENDIX A.

LIST OF PLACES REPORTED TO BE INFECTED WITH CHOLERA, 1909-1915.

—	Year.						
	1909.	1910.	1911.	1912.	1913.	1914.	1915.
Algeria—							
Algiers	..	..	1	..	..	..	..
Arabia—							
Hodeidah	..	..	214	2	3	..	..
Maskat	..	83	7	..	..	..	..
Austria-Hungary—							
Austria	..	..	..	..	..	4,208	31,169
Adelsberg	..	..	..	..	..	..	2
Apatin	..	..	..	..	3	..	..
Arbe	..	..	6	..	..	..	..
Bohemia	..	..	..	..	..	176	..
Prague	..	..	..	..	..	3	..
Brod	..	..	..	..	11	..	..
Capodistra	..	..	12	2	..	..	..
Cittanova	..	..	1	..	..	..	..
Galicia	..	..	..	..	..	2,047	..
Grad	..	..	..	..	3	..	..
Kracow	..	..	..	..	..	109	..
Liskow	..	..	..	..	..	355	..
Przemsyl	..	..	..	..	..	132	..
Laibach	..	1	..	..	..	..	15
Lower Austria	..	..	..	..	..	473	..
Vienna	..	..	..	..	..	312	87
Moravia	..	..	..	..	..	362	..
Brunn	..	..	..	..	..	18	..
Mitrovica	..	..	..	..	10	..	..
Mohacs	..	22	..	..	15	..	..
Obecse	..	..	..	..	7	..	..
Palank	..	..	..	..	16	..	..
Pancsova	..	..	..	..	1	..	..
Parenzo	..	..	11	..	..	..	..
Semlin	..	..	1	..	12	..	..
Silesia	..	..	..	..	..	288	..
Stiermark	..	..	..	..	..	6	..
Styria	..	..	..	..	..	55	..
Gratz	..	..	..	..	..	10	..
Szenttamas	..	..	..	..	31	..	..
Trieste	..	1	42	..	..	5	80
Tuzla	..	..	..	..	2	..	..
Tyrol and Vorarlberg	..	..	..	..	..	3	..
Upper Austria	..	..	..	..	..	3	..
Vinkovci	..	..	..	..	5	..	..
Bosnia-Herzegovina	..	..	..	..	..	..	512
Croatia-Slavonia	..	..	..	..	..	..	1,503
Esseg (City)	..	..	..	..	3	..	4
Fiume	..	..	4	..	..	..	3
Crownlands	..	..	..	..	..	469	..
Hungary	..	..	..	..	..	3,494	3,868
Budapest	..	..	..	..	..	223	27
Balkan Territory	..	..	..	..	..	..	7
Belgium—							
Antwerp	9	..	..	..	..	..	..
Brazil—							
Para	..	2	..	..	..	..	..

APPENDIX A.—LIST OF PLACES REPORTED TO BE INFECTED WITH CHOLERA, 1909–1915 —*continued.*

—	Year.						
	1909.	1910.	1911.	1912.	1913.	1914.	1915.
Bulgaria—							
Burgas	..	..	4	2	..	..	..
Eski Saghara	..	..	..	..	2	..	..
Rustschuk	..	..	..	..	18	..	..
Sistovo	..	..	..	..	60	..	..
Sofia	..	..	..	1	6	..	..
Tirnovo	..	..	..	..	14	..	..
Varna	..	3	4	1	73	..	..
Canada—							
Quebec	..	1	..	..	..	..	..
Ceylon—							
Colombo	16	9	22	1	53	12	9
Galle	..	..	..	..	..	12	..
Uda Pusselawa	..	..	..	..	..	present	..
China—							
Amoy	435	6	4	12	..	1	..
Kulangsu	..	..	..	..	..	1	..
Canton	..	..	..	..	132	4	..
Chaochowfu	..	..	..	..	..	present	..
Chefoo	5	..	..	..	..	..	..
Dalny	29	6	35	..	..	..	..
Foochow	..	..	..	..	..	..	..
Hangkow	14	7	..	6	..	1	..
Hong Kong	2	9	..	1	99	11	..
Kinchow	..	..	10	..	..	..	..
Liaouang	1	..	..	..	..	..	..
Mukden	1	..	..	..	..	..	..
Nanking	..	..	..	14	..	present	..
Shanghai	3	..	1	20	10	..	..
Swatow	..	..	..	41	31	..	..
Vashihehias	1	..	..	..	..	..	..
Wuchow	..	..	..	..	..	present	..
Denmark—							
Copenhagen	..	1	..	..	..	..	..
Dutch East Indies—							
Borneo	..	..	..	..	..	..	6
Bandjermasin	..	..	..	..	..	..	epidemic
Bode	..	..	..	..	..	..	8
Putatan	..	..	..	..	..	..	5
Sandakan	..	..	..	..	..	..	7
Membakut Estate	..	..	..	..	..	..	6
Simporna	..	..	..	..	..	..	60
Banca—							
Muntok	..	..	..	..	..	11	..
Celebes—							
Gorontalo	..	..	..	..	..	present	..
Macassar	..	..	..	..	..	163	..
Menado	..	..	..	..	..	425	..
Java	..	..	..	..	..	..	236
Batavia	1,202	823	633	448	864	..	..
Batavia and Tanjong Priok	..	..	..	..	..	377	143
Brebes	..	..	..	..	..	..	11
Celebes	..	..	..	5	..	..	..
Cheribon	..	..	..	..	..	..	7
Pamanockan	..	..	..	..	..	1	..
Prebalongan	..	..	..	..	110	..	..
Rembang	..	..	..	2	..	..	..
Samarang	..	1,161	620	1	622	8	..

Appendix A.—List of Places reported to be infected with Cholera, 1909–1915 —*continued.*

—	Year.						
	1909.	1910.	1911.	1912.	1913.	1914.	1915.
Dutch East Indies—*continued.*							
Java—*continued.*							
Surabaya	..	445	72	44	6	..	..
Surakarta	..	..	100	..	..	..	..
Sumatra—							
Benkoelen	..	..	..	..	3	..	..
Jambi	..	..	..	..	1	..	..
Lampong	..	..	..	..	..	27	..
Mengals	..	..	..	..	..	65	..
Padang	..	..	..	..	5	136	..
Baros	..	..	..	..	..	55	..
Sorkam	..	..	..	..	..	22	..
Palembang	..	936	..	..	278	352	..
Pencoulen District	..	..	..	..	..	88	..
Samarinda	..	..	..	..	26	..	..
Sinkawang	..	..	..	..	2	..	..
Telokbetong	..	..	..	..	181	47	..
Egypt—							
Alexandria	..	..	3	..	..	..	..
Anglo-Egyptian Sudan	..	..	..	..	..	2	..
France—							
Marseille	..	4	226	..	..	..	..
Germany	..	..	..	..	..	..	409
Ahlen	..	..	..	..	..	..	1
Allenstein	..	..	..	..	..	..	1
Altona	..	..	..	..	..	..	1
Berlin	..	..	..	..	..	..	5
Berlitz	..	..	..	..	..	..	1
Brandenburg-on-the-Oder	..	..	..	..	..	4	2
Breslau	..	..	..	..	..	..	5
Bromberg	..	..	..	..	..	..	2
Constatt	..	..	..	..	..	..	1
Freiberg	..	2	..	..	..	..	..
Kalthoff	..	10	..	..	..	..	..
Konigsberg	1	..	..	..	..	..	5
Labiau District	4	..	..	..	..	..	..
Marienburg	..	16	..	..	..	..	..
Torgau	..	..	..	..	..	..	1
Government Districts—							
Arnsberg	..	..	..	..	..	..	3
Breslau	..	..	..	..	..	..	6
Frankfort	..	..	..	..	..	..	2
Gumbinnen	..	..	..	..	..	..	4
Koslin	..	..	..	..	..	..	4
Liegnitz	..	..	..	..	..	..	4
Luneburg	..	..	..	..	..	..	1
Magdeburg	..	..	..	..	..	..	1
Marienwerder	..	..	..	..	..	..	605
Merseburg	..	..	..	..	..	..	12
Minden	..	..	..	..	..	..	2
Munster	..	..	..	..	..	..	1
Oppeln	..	..	..	..	..	..	38
Potsdam	..	..	..	..	..	..	5
Schleswig	..	..	..	..	..	..	9
Stade	..	..	..	..	..	..	2
Stettin	..	..	..	..	..	..	14
Wiesbaden	..	..	..	..	..	..	1
Danzig	..	..	..	..	..	..	19
Dansig-Troyl	..	..	..	..	..	..	17
Erfurt	..	..	..	..	..	..	1

Appendix A.—List of Places reported to be infected with Cholera, 1909–1915—*continued.*

—	Year.						
	1909.	1910.	1911.	1912.	1913.	1914.	1915.
Germany—*continued.*							
Frankfort-on-Oder	..	..	..	..	..	..	2
Furstenwalde and Klotsch	..	..	..	..	..	..	4
Hamburg	..	..	..	..	..	..	4
Hanover	..	..	..	..	..	..	1
Hermanshohe	..	..	..	..	..	..	7
Jagendorf	..	..	..	..	..	..	1
Kehl	..	..	..	..	..	..	3
Kiel	..	..	..	..	..	..	1
Kosel	..	..	..	..	..	..	1
Kronshagen	..	..	..	..	..	..	1
Landsberg	..	..	..	..	..	..	1
Leipsig	..	..	..	..	..	..	1
Marggrabowa	..	..	..	..	..	..	present
Nierderzaden	..	..	..	..	..	..	1
Patschkau	..	..	..	..	..	..	1
Posen	..	..	..	..	..	2	1
Zirka	..	..	..	..	..	..	5
Silesia	..	..	..	..	..	73	5
Rosenberg	..	..	..	..	..	..	2
Sachsenhausen	..	..	..	..	..	..	1
Saxony (Kingdom)	..	..	..	..	..	..	2
Schneidemuhl	..	..	..	..	..	..	1
Slaventzitz	..	..	..	..	..	..	1
Sommerfeld	..	..	..	..	..	..	1
Spandau	..	..	..	..	..	..	1
Striegan	..	..	..	..	..	..	1
Thorn	..	..	..	..	..	..	2
Tilsit	..	..	..	..	..	..	2
Treptow	..	..	..	..	..	..	2
Great Britain—							
Hartlepool	1	..	..	..	..	..	..
Greece—							
Athens	..	..	..	..	1	..	..
Janina	..	..	..	..	..	1	..
Piraeus	..	..	3	..	9	1	..
Surgun Tschadalza	..	..	..	..	..	1	..
Viza	..	..	..	..	..	1	..
Hawaii—							
Honolulu	..	..	39	..	..	..	..
India—							
Akyab	..	..	..	..	..	..	7
Bahrein Island	..	..	..	..	260	..	..
Bassein	..	..	16	204	303	143	..
Bombay	844	75	113	2,043	278	321	24
Calcutta	2,239	1,799	1,760	8,325	1,571	1,535	541
Cocanda	..	..	..	16	..	..	44
Cochin	..	..	..	18	11	..	..
Henzada	..	..	..	..	..	..	21
Karachi	..	..	..	..	..	..	1
Kashmir-(Province)	..	..	..	..	..	Endemic	
Kurrachee	..	43	..	140	..	..	..
Madras	68	130	508	797	59	2,035	212
Madras Presidency	..	..	..	..	..	..	10
Madras District	..	..	..	..	..	..	633
Mandalay	..	..	..	..	..	..	224
Mergui	..	..	..	..	..	..	93
Moulmine	..	17	40	69	18	31	..
Myingyan	..	..	..	..	..	..	1

APPENDIX A.—LIST OF PLACES REPORTED TO BE INFECTED WITH CHOLERA, 1909–1915 —*continued.*

—	Year.						
	1909.	1910.	1911.	1912.	1913.	1914.	1915.
India—*continued.*							
Negepatum	73	358	35	79	78	130	..
Pakakku	..	..	..	..	..	..	71
Pegu	..	..	..	..	..	..	1
Pondicherry	..	..	..	4	..	..	..
Rangoon	186	72	121	247	60	44	28
Toungoo	..	..	..	..	..	..	2
Indo-China	..	..	..	..	..	..	284
Baria	..	..	..	..	..	18	..
Battambang	..	..	..	..	..	5	..
Provinces—							
Annam	..	..	..	..	..	..	93
Cochin China	..	..	..	..	..	..	621
Laos	..	..	..	..	..	10	46
Tonkin	..	..	..	..	..	..	84
Saigon	27	80	232	2,538	44	..	2,804
Binh-Dinh	..	..	..	..	..	84	..
Ninh-Binh	..	..	..	..	..	11	..
Pakse	..	..	..	..	..	1	..
Cambodia—							
Pnum Penh	..	..	..	..	..	2	..
Cholon	..	..	..	..	..	29	..
Hanoi	..	..	..	..	..	2	..
Phanri	..	..	..	..	..	..	3
Soctrang	..	..	..	..	..	3	..
Scairieng	..	..	..	..	..	1	..
Travinh	..	..	..	..	..	43	..
Italy—							
Barletta	..	167	..	..	..	..	..
Bisceglie	..	4	..	..	..	..	..
Carbonara	..	1	..	..	..	..	..
Genoa	..	..	279	..	..	..	..
Girgenti	..	..	..	105	..	..	..
Naples	..	329	927	..	..	..	..
Palermo	..	46	1,503	..	..	..	..
Reggio di Calabria	..	..	2	..	..	..	..
Rome	..	29	..	..	..	..	..
Sardinia	..	5	..	..	..	..	..
Spinazzola	..	15	..	..	..	..	..
Terracina	..	6	..	..	..	..	..
Trani	..	93	..	..	..	..	..
Cerignola	..	38	..	..	..	..	..
Provinces—							
Allessandria	..	..	115	..	..	..	..
Ancona	..	..	8	..	..	..	..
Aquila	..	..	128	..	..	..	..
Ascoli	..	..	1	..	..	..	..
Avellino	..	7	234	..	..	..	..
Bari	..	..	508	..	..	..	..
Benevento	..	..	96	..	..	..	..
Bergamo	..	..	118	..	..	..	..
Bologna	..	..	30	..	..	..	..
Cagliari	..	..	197	64	..	..	..
Caltanisetta	..	6	375	9	..	..	..
Campobasso	..	7	765	..	..	..	..
Carrara	..	..	10	..	..	..	..
Caserta	..	313	1,941	..	..	..	..
Catania	..	16	882	..	..	..	..
Catanzara	..	..	164	..	..	..	..

APPENDIX A.—LIST OF PLACES REPORTED TO BE INFECTED WITH CHOLERA, 1909–1915 —*continued.*

—	Year.						
	1909.	1910.	1911.	1912.	1913.	1914.	1915.
Italy—*continued.*							
Provinces—*continued.*							
Chieti	..	..	117	..	..	..	..
Cozena	..	..	107	..	..	..	..
Ferrara	..	..	50	..	..	..	..
Florence	..	..	6	..	..	..	..
Foggia	..	..	204	..	..	..	..
Forli	..	..	47	..	..	..	..
Genoa	..	..	405	..	..	..	..
Girgenti	..	8	383	..	..	..	..
Leghorn	..	..	768	..	..	..	1
Lucca	..	..	10	..	..	..	..
Massa	..	..	87	..	..	..	..
Messina	..	1	235	3	..	..	..
Milan	..	..	20	..	..	..	..
Naples	..	193	1,317	..	..	..	..
Novara	..	..	4	..	..	..	..
Padua	..	..	9	..	..	..	..
Palermo	..	..	561	..	..	..	..
Pesaro	..	..	108	..	..	..	..
Pisa	..	..	18	..	..	..	..
Potenza	..	..	55	..	..	..	..
Reggio di Calabria ..	..	..	6	..	..	..	..
Reggio Emillo	..	..	1	..	..	..	..
Rome	..	64	340	..	..	..	..
Rovigo	..	..	78	..	..	..	..
Salerno	..	28	1,387	..	..	..	..
Sassari	..	..	9	..	..	..	..
Syracuse	..	..	149	15	..	..	..
Venice	..	..	302	..	..	..	3
Vincenza	..	..	1	..	..	..	..
Japan—							
Chiba	..	..	..	75	116	..	..
Formosa	..	..	11	65	..	..	..
Fukuoka	..	166	234	673	816	..	..
Fukushima	..	..	..	..	1	..	..
Hiogo	..	..	607	57	137	..	..
Hiroshima	..	57	58	33	49	..	..
Kagoshima	..	3	4	5	11	..	..
Kanagawa	..	..	..	..	122	..	..
Karatsu	..	..	..	..	..	2	..
Kobe	4	534	4	27	7	..	..
Kochi	..	69	70	17	25	..	..
Kumamoto	..	..	19	11	15	..	..
Kyoto	200	141	143	10	5	1	..
Matsuyama	..	23	..	..	..	..	..
Moji	5	44	..	..	..	..	..
Miyako Islands	..	..	..	81	..	..	..
Nagasaki	..	17	27	121	190	..	..
Nagoya	..	1	..	..	..	..	..
Nara	..	29	31	..	..	..	..
Oita	..	..	2	49	38	..	..
Okayama	..	68	49	66	67	..	..
Okinawa	..	..	..	26	..	..	..
Osaka	1	939	957	144	165	..	..
Saga	..	45	51	84	109	4	..
Shimabara	..	..	..	3	..	..	..
Shimonoseki	..	..	..	40	..	..	..
Taiwan	..	..	..	..	338	..	..

APPENDIX A.—LIST OF PLACES REPORTED TO BE INFECTED WITH CHOLERA, 1909–1915 —*continued.*

—	Year.						
	1909.	1910.	1911.	1912.	1913.	1914.	1915.
Japan—*continued.*							
Tokushima	..	59	59	6	3	..	..
Tokyo	..	1	1	250	314	..	..
Wakamatsu	2	2	..	68	1	..	..
Yamaguchi	..	37	41	315	267	..	..
Yokohama	..	1	..	33	39	..	..
Madeira—							
Calheta	..	..	1	..	..	..	..
Funchal	..	77	635	..	..	..	..
Ponto do Sol	..	..	195	..	..	..	..
Santa Cruz	..	..	89	..	..	..	..
Malta	..	..	27	6	..	..	..
Moluccas—							
Amboyna	..	..	12	..	..	..	..
Montenegro—							
General	..	..	47	9	..	..	..
Cettinje	..	..	2	..	..	..	..
The Netherlands—							
Amsterdam	1	..	..	..	..	..	..
Breda	1	..	..	..	..	..	..
Rotterdam	34	1	..	..	..	..	..
Utrecht	1	..	..	..	..	..	..
Persia—							
Anzali	..	..	..	..	..	1	..
Dilman	..	..	..	..	..	..	present
Kerman	..	..	106	..	..	..	..
Khoi	..	..	..	..	..	..	present
Mohammerah	..	..	277	..	..	..	..
Tabriz	..	..	..	..	..	..	175
Philippine Islands—							
Antique	260	..	..	..	..	..	..
Batangas	..	1,428	..	..	..	..	..
Bohol	710	50	..	..	..	..	..
Camarines	..	5	..	..	..	..	..
Cebu	821	333	..	..	..	..	..
Isabella	26	..	..	..	..	..	..
Leyte	189	36	..	..	..	..	..
Manila	258	562	10	..	110	562	104
Mindoro	..	12	37	..	..	..	..
Misamis	42	42	..	..	..	..	..
Palawan	10	..	..	..	..	..	..
Samar	238	..	..	..	..	..	..
Surigao	7	..	..	..	..	..	..
Tarlac	66	286	..	..	..	..	..
Provinces—							
Amburayan	..	..	..	..	..	5	..
Bataan	..	..	..	..	..	2	..
Bulacan	..	..	..	..	..	310	..
Cagayan	397	..	..	..	..	3	..
Capiz	1,535	3	..	..	..	present	..
Cavite	142	122	..	..	1	38	..
Ilocos Sur	..	..	..	..	..	8	..
Iloilo	523	..	..	..	..	2	..
Laguna	119	4	1	..	..	35	..
Mountain	..	..	..	..	..	3	..
Pampanga	..	..	..	..	..	48	..
Pangasinan	..	..	..	..	..	46	..
Rizal	..	..	..	..	..	126	..
Tayabas	..	..	..	..	..	2	..
Union	..	..	..	..	..	497	..

APPENDIX A.—LIST OF PLACES REPORTED TO BE INFECTED WITH CHOLERA, 1909–1915 —*continued.*

—	Year.						
	1909.	1910.	1911.	1912.	1913.	1914.	1915.
Roumania—							
Arges	..	..	..	..	59	..	..
Braila	..	..	60	84	265	..	..
Galatz	..	1	..	..	34	..	..
Bucharest	..	..	..	..	1	..	..
Buzau	..	..	..	..	79	..	..
Constanta	..	..	..	..	114	..	..
Kustenje	..	..	..	..	8	..	..
Roman	..	..	..	..	1	..	..
Silistra	..	..	..	..	26	..	..
Sulina	..	..	..	..	56	..	..
Russia—							
Akmolinsk Territory	34	723	..	..	..	..	..
Akkerman	..	..	..	..	11	..	..
Alexandrovosk	10	16	..	..	..	..	..
Amur Territory	..	141	..	..	..	..	..
Archangel Government	368	4	..	..	..	..	present
Baku Government	77	1,108	7	..	..	..	..
Baku	..	1,044	11	..	..	..	..
Batoum Territory	4	14	2	..	..	..	..
Black Sea Province	..	504	..	..	..	..	..
Courland	..	5	..	..	..	..	..
Kronstadt	69	230	..	..	..	..	..
Dorpat	1	..	..	..	..	..	..
Finland	..	3	..	..	..	..	..
Grodno	32	..	..	..	..	..	..
Helsingfors	2	..	..	..	..	..	..
Kars Territory	..	707	..	..	..	..	..
Kem	47	..	..	..	..	..	..
Kertsch	..	490	..	..	..	..	..
Kazan Government	..	..	12	..	..	..	..
Kharkov Government	20	2,638	2	..	..	..	..
Kherson Government	3	8,842	6	..	113	..	..
Kief Government	77	3,371	45	..	..	..	present
Kooban Government	139	49,603	5	..	..	..	..
Kretsky	1	..	..	..	..	..	..
Kursk Government	3	5,379	..	..	..	..	..
Minsk Government	..	503	4	..	1	..	..
Mitau	28	..	..	..	..	..	..
Moscow	..	..	..	..	..	present	present
Novorossysk	..	7	14	..	..	..	..
Odessa	2	..	3	..	53	..	..
Omsk	..	..	2	..	..	..	..
Orel Government	..	452	..	..	..	..	..
Orenburg Government	..	2,947	15	..	..	..	..
Perm Government	27	684	2	..	..	..	..
Podolia—							
Bratzlaw	..	..	..	..	..	1	..
Jampol	..	..	..	..	..	25	..
Letichev	..	..	..	..	..	2	..
Litine	..	..	..	..	..	8	..
Vinnitza	..	..	..	..	..	220	..
Pskov Government	142	16	..	..	..	..	..
Rostov	..	3,084	54	..	..	..	..
Reni	..	..	..	..	1	..	..
Reval	2	..	..	..	..	..	..
Riga	331	27	..	..	..	..	..
Rjasan Government	..	2,022	2	..	..	..	..
Samara Government	90	10,251	2,186	..	..	..	..

APPENDIX A.—LIST OF PLACES REPORTED TO BE INFECTED WITH CHOLERA, 1909–1915 —*continued.*

—	Year.						
	1909.	1910.	1911.	1912.	1913.	1914.	1915.
Russia—*continued.*							
Samarcand	10	..	..	..	..	..	..
Saratov Government ..	41	6,030	207	..	..	..	..
Semipalatinsk Government	1	..	..	..	..	..	..
St. Petersburg Government	9,532	4,944	34	..	..	..	..
Tiflis	..	1,719	2	..	..	..	..
Tobolsk Government ..	..	146	..	..	..	..	..
Tomsk Government ..	102	329	..	..	..	..	..
Tula Government ..	..	34	..	..	..	..	..
Veronesch Government ..	..	4,565	7	..	..	..	..
Vilna Government ..	61	..	..	..	..	..	..
Vitebsk Government ..	764	316	4	..	..	..	..
Vladimir Government ..	..	25	..	..	..	..	..
Volgoda Government ..	544	195	..	..	..	..	..
Warsaw	..	..	..	..	..	present	..
Yaroslav Government ..	..	1,159	..	..	..	..	..
Yekaterinslav	..	14,873	..	..	..	..	..
Vladivostok	157	1	..	..	..	..	..
Viborg	1	..	..	..	..	..	2
Servia—							
Belgrade Department ..	..	..	12	..	149	..	..
Belgrade	..	10	..	6	345	..	..
Kragujevatz Department ..	..	..	..	..	313	..	..
Morava Department ..	..	..	..	..	641	..	..
Palanka Department ..	..	..	..	..	1	..	..
Smederevo Department ..	..	..	..	..	215	..	..
Smederevo	..	..	13	..	..	..	..
Pirot Department ..	..	..	..	..	752	..	..
Timok	..	..	..	..	296	..	..
Siam— ..							
Bangkok	4	1,104	2,321	2,811	35	present	present
Straits Settlements—							
Kedah (Province) ..	..	..	..	..	..	1,733	..
Penang	1	..	10	..	..	1	..
Singapore	187	122	226	115	57	304	5
Sumatra Island—							
Toba District	..	..	..	..	..	159	..
Sweden—							
Stockholm	1	..	..	..	..	..	..
Tripoli—							
Tripoli	..	253	41	2,000	..	..	..
Tunis—							
Bizerta District	..	..	610	9	..	..	..
Jerba	..	19	..	..	..	..	..
Tunis	..	..	461	53	..	..	..
Turkey-in Asia—							
Adana	..	..	45	230	2	..	..
Aintab	..	..	..	..	23	..	..
Aivali	..	..	..	..	..	9	..
Alaya	..	..	..	..	1	..	..
Alexandretta	..	..	..	8	3	..	..
Aleppo	..	..	..	393	5	..	..
Angora	..	..	..	..	29	..	..
Antioch	..	..	..	39	..	..	..
Ayas	..	..	..	12	..	..	..
Basra	..	259	371	14	..	..	..
Beirut	..	7	2	15	..	..	..
Bor	..	..	..	24	..	..	..
Brusa	..	..	..	..	26	..	..

APPENDIX A.—LIST OF PLACES REPORTED TO BE INFECTED WITH CHOLERA, 1909–1915 —*continued.*

—	Year.						
	1909.	1910.	1911.	1912.	1913.	1914.	1915.
Turkey-in-Asia—*continued.*							
Ergeli	..	..	..	99	..	present	..
Eski-Cheri	..	..	..	..	..	2	..
Haifa	..	..	49	..	1	..	..
Idlb	..	..	..	6	..	..	..
Iskilib	..	..	..	4	..	..	..
Ismid	..	..	..	2	3	..	..
Jaffa	..	..	3	..	..	..	..
Jiddah	..	..	..	323	..	..	..
Kamaran	..	..	8	..	..	1	..
Kartal	..	..	..	..	9	..	..
Kerassunde	..	..	22	..	..	..	..
Killis	..	..	..	45	..	..	..
Latakia	..	..	..	8	..	..	..
Samsoun	..	12	302	..	..	..	..
Sinope	..	..	..	2	1	..	..
Smryna	..	10	1,329	1	296	present	..
Surmene	..	1	..	..	..	..	..
Syria	..	..	..	81	..	..	..
Medina	..	..	857	104	6	..	..
Mekka	..	..	896	953	111	..	..
Mersina	..	..	1	42	..	..	..
Mohammerah	..	43	..	..	..	..	..
Tagadima	..	..	..	..	..	2	..
Trebizond	..	639	112	64	..	present	..
Tripoli	..	..	43	..	..	..	..
Acre	..	..	..	33	..	..	..
Balekesir	..	..	..	..	1	..	..
Turkey-in-Europe—							
Adrianople	..	94	60	..	..	114	..
Constantinople	..	477	3,458	925	1,687	present	present
Dardanelles	..	..	3	..	..	23	..
Gallipoli	..	..	..	..	..	2	..
Kavala	..	..	..	..	1	..	..
Kirk Kilisse	..	..	..	..	..	2	..
Pera	..	..	..	..	..	5	..
Rodosto	..	..	..	..	12	15	..
Saloniki	..	2	831	4	623	..	..
Silviri	..	..	..	..	4	..	..
Valona	..	..	28	..	..	..	..
Zanzibar	..	..	..	260	131	..	..

NOTE.—The figures are not to be considered as complete. They represent the total compiled from all available sources of information, and in many cases the reports cover only short periods and not complete years.

APPENDIX B.

CHOLERA.

The following questions were referred by the Convention to the Technical Sub-Committee on Cholera* :—

Are there grounds for defining in the Convention the interpretation of a proved case and a suspected case of Cholera. What should be such definition?

Are there grounds for prescribing, or at least for indicating, the procedure to be followed in the bacteriological diagnosis of cholera?

Should a definition be given of cholera carriers, and, if so, in what terms?

What is the actual importance of cholera carriers in the spread of the disease. In relation to this importance is it necessary to include carriers in the scheme of international prophylaxis to the extent of making them the object of special measures?

In the event of such being considered necessary, what should be such measures. Should they be applied merely around a cholera focus, or also under other circumstances or conditions to be prescribed?

What measures should be provided in respect of drinking water taken on at infected ports?

What measures should be taken in respect of water ballast. What are the most effective and the most practical methods for the disinfection of such water?

The report of the Sub-Committee is given hereunder :—

Report† of the Cholera Sub-Committee of the Paris Convention, 1912.

Presented by the Chairman—Prof. van Emengem.

The report of the technical Sub-Committee of the Sanitary Conference assembled in Paris in 1903, stated its conclusions on the subject of cholera as follow :—

"The organism which causes this disease, and the method of its propagation, were well known in 1893, thanks to the work of Koch and his pupils. Accordingly the measures prescribed against cholera by the International Convention of Dresden can be maintained without alteration."

Since 1893, and principally during the last ten years, our knowledge of the cholara organism, of its specific characteristics, our knowledge of its detection in sick persons and even in healthy carriers, and of the diverse ways in which it may be transported, has become more complete and more accurate.

It has been the duty of this Sub-Committee to examine this new scientific data, and to select the facts which may serve as bases for improvements in the rules of international prophylasis which have been laid down by the Convention of 1903—

(1) The infection of cholera develops rapidly, and its manifestations appear some hours, at the latest three to five days, after the introduction of the specific vibrios into the digestive tract.

This important fact, upon which former Conventions have based several of the measures which they have prescribed, is confirmed by recent observations.

The Sub-Committee restates this point in a first resolution as follows :—

> *The period of incubation of cholera is short. It does not, as a rule, exceed five days.*

(2) The cholera patients constitutes the original environment of the cholera vibrios. Recent discoveries have invariably confirmed this observation, which is obviously of fundamental importance from the point of view of the propagation and prophylaxis of cholera.

In order that the preponderating rôle played by the cholera patient in the diffusion of this disease may be more clearly defined, the Sub-Committee has decided to commence by defining the part played by other agents in the dissemination of the specific micro-organisms.

A priori, it cannot be denied that many objects, such as merchandise, and especially articles of food, can act as accidental carriers of cholera vibrios, if such articles have become suitable soil in which the vibrios can remain for some time alive.

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* See Procés Verbaux, p. 255. † See Procés Verbaux, p. 370.

No scientifically controlled experiment has, however, been hitherto forthcoming supporting the transmission of the vibrios for any considerable distance by such articles. There is not known any instance of the importation of cholera from an infected country to a cholera-free country by merchandise or food stuffs.

In certain localities, during an actual epidemic, considerable quantities of vegetables and fruit from neighbouring cholera-infected localities have been consumed, yet cholera has nevertheless not occurred in the localities into which such vegetables or fruits have been introduced.

The carriage of cholera vibrios by articles of food can, however, occur within a limited range. Instances have recently been recorded of localized epidemics which have occurred in localities in which the disease was prevalent and which occurred amongst groups of persons or of families which had consumed jellies or oysters.

All such epidemic foci due to articles of food have their origin, so to speak, on the spot, and hardly extend beyond the environment constituted by the persons directly associated with the actual patient.

The danger to be anticipated from food commodities is, therefore, not in the least comparable to the risks offered by human carriage of infection, which knows no limitations other than those imposed on the movements of the man himself.

There is no new fact which tends to diminish the importance, which has been long recognised, of man as the principal factor in the dissemination of cholera. The Sub-Committee has confirmed this principle by the following declaration :—

> *The virus of cholera is contained in human excreta. Man himself is the principal agent in its diffusion.*

(3) This declaration finds its immediate corollary in a third proposition as follows :—

> *The great human currents (pilgrimages, emigration, markets, &c.), are of the first importance in the spread of cholera. So far as such movements of large bodies of people are concerned, the measures of control to be recommended before all others, are those taken before departure or during the journey.*

(4) The programme proposed to the Conference admits, among other questions of technical nature, of a definition of what should be understood by proved cases and by suspected cases of cholera, as well as a suitable definition for *porteurs de germes.* The definition of these three groups of persons who are capable of transporting and disseminating cholera vibrios, has been drawn up as follows :—

> *Verified cholera should be defined—cholera diagnosed according to clinical or anatomo-pathological symptoms, confirmed by bacteriological findings, establishing clearly the nature of the disease.*
>
> *Suspected cases of cholera are those which present clinical symptoms, but in which the bacteriological examination of the excreta has not, so far, revealed the presence of cholera vibrios. In practice, the case may be considered as free from suspicion when at least two bacteriological examinations, with one day's interval between them, has not revealed cholera vibrios.*
>
> *"Porteurs de germes" (carriers) are persons convalescent from cholera, or persons without any symptom of illness, who discharge continuously or intermittently cholera vibrios in their excreta.*
>
> *It would not seem advisable to restrict so important a definition as that of "carriers" merely to healthy persons discharging vibrios. Among the groups of carriers should be included also persons convalescent from an established attack of cholera, and also those who have exhibited an attack of mild or indefinite cholera, for in practice such could not be distinguished from healthy persons discharging vibrios.*

(5) The significance and the import of bacteriological diagnosis are such that it has been rightly said that it constitutes the keystone of all the structure of prophylaxis.

Thanks to the very complete investigation recently undertaken under the auspices of the Committee of the International Office of Hygiene, by a commission of the most competent experts, the examination of this question by our Sub-Committee has been greatly facilitated.

The Sub-Committee has concerned itself with the defining of certain technical details, to draw attention to the practical value of some others, and to emphasize the difficulties introduced into the bacteriological diagnosis of cholera by the existence of typical varieties of vibriones.

It is well recognised that the technical data which the Sub-Committee has here recognised do not represent more than a scheme permitting investigators who are not specially qualified in this work to arrive readily at a diagnosis under conditions offering security sufficient for the needs of administrative public health services, and no particular method of research is prescribed, nor indeed recognised, as conclusive.

The text of the conclusions of the International Offices, adopted with slight modifications by the Sub-Committee, is as follows :—

> *The methods applicable to the search for and identification of the cholera vibrio permit the trained bacteriologist to conduct the bacteriological diagnosis of cholera with a degree of accuracy sufficient for the needs of prophylaxis.*
>
> *In practice it can be taken as a rule that every "choleriform vibrio" may be accepted as being a cholera vibrio if it exhibits either of the two following characteristics:—*
>
> (1) *If it is agglutinated in a dilution of at least 1 in 1,000 by a serum of which the activity is equal or superior to 1 in 4,000.*
>
> (2) *If it shows the reaction of Pfeiffer.*
>
> *Every clinical condition which is similar to cholera or which presents symptoms of gastro-enteritis, and in which a vibrio satisfying the above description of a cholera vibrio is found, should on these grounds be considered to be a case of cholera.*
>
> *When the cases under investigation are the first suspected cases in a country previously free from cholera, it is advisable that both of the above reactions should be obtained before a definite diagnosis of cholera is accepted.*
>
> *If repeated attacks of any illness showing the clinical symptoms and anatomo-pathological lesions of cholera have occurred, and the bacteriological examination shows the existence in the faeces of the patient or in the intestinal contents of the cadaver of vibrios similar to cholera vibrios, it is reasonable to suspect the existence of cholera, even if the isolated vibrios do not agglutinate at a titre of 1—1,000, and if the attempt to obtain the phenomenon of Pfeiffer is not successful. In such cases, which must, however, be always considered as exceptional, it is essential that the bacteriological examinations be repeated until all uncertainty is removed.*
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> *There are instances, so far few in number, in which have been found, on the one hand in the persons of healthy individuals for whom the probability of choleraic infection has not been demonstrated; and on the other hand in cases of illness in which neither the clinical signs nor pathological lesions of cholera have been met with—vibrios having all the characteristics of cholera vibrio.*
>
> *Science has not determined whether such should or should not be considered as true cholera vibrio. Bacteriology does not furnish at this moment any reactions which enable usefully practical differentiation to be made between the various strains of cholera vibrios.*
>
> *It would be neither possible nor desirable to prescribe for the technique of bacteriological examination, any procedure defined by rigid rules. But it is possible to recommend in a general way the procedure which, if followed, will, in the majority of cases, enable a diagnosis to be arrived at within 24 to 36 hours.*
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> (1) *When mucous flakes are available, these should be examined microscopically, both in stained preparation and in hanging drop.*
>
> (2) *Isolation of vibrios by plating on agar media at 37 deg.*
>
> (a) *Plating on ordinary agar suitably alkalinized, and on Dieudonnes medium—in the latter case a mucous flake or a corresponding quantity of faeces, should be employed.*

(*b*) *Inoculation of 1 c.c. of suspected material into 50 c.c. of peptone water, after six hours incubation at 37 deg. (and if necessary after 12 or 18 hours), remove loopfuls of culture from the surface of the peptone water, and inoculate on plates of Dieudonne and of ordinary agar.*

(*c*) *Testing the various isolated colonies by the agglutination method, selecting those apparently belonging to the cholera group and obtaining these in pure culture.*

(*3*) *Classification of such vibrios, when obtained in pure culture, according to their agglutination and Pfeiffer test results.*

The conditions are the more favorable for the discovery of the cholera vibrio in proportion as the material used for investigation is obtained at a period more nearly to the onset of the illness or taken from the small intestine as soon as possible after death.

Examinations made upon the small quantity of material which is brought away by a sound introduced into the rectum either from the living person or the cadaver are inconclusive.

It is sometimes possible to recognise that a person, even a healthy person, has passed through an attack of cholera, by testing whether his serum gives with the cholera vibrio the reactions of immunity agglutination or better still Pfeiffer's phenomenon.

(6) The most delicate, the most difficult, and the most serious amongst the questions referred to our Sub-Committee was, clearly, that of the importance of "carriers" in connexion with the spread of cholera, and the practical value that their detection would have in the domain of prophylaxis. While this question of "carriers" is not a new one, since it was already definitely considered in 1893, its importance has only been recognised since the rôle of bacillus carriers has, thanks to an accumulation of extraordinary evidence, been recognised as the predominant factor in the endemicity of typhoid fever.

Unfortunately, so far as cholera is concerned, the very numerous observations, collected during the recent invasion of Europe by cholera, have so far furnished only very fragmentary data, and our knowledge remains inexact and very incomplete on the principal aspects of this problem.

During two of its sessions the Sub-Committee has heard noteworthy communications on this subject, notably from the delegates from Germany, Italy, Russia, Austria, Egypt, Roumania, and Holland, and careful discussions have been held upon many of the points raised in these communications. To these discussions the delegates from France, Great Britain, Egypt, Italy, Portugal, Turkey, &c., have contributed brilliantly.

It would be a long and difficult task to record faithfully all the opinions (sometimes very divergent) expressed during these debates, or even to merely give a *résume* of the arguments adduced in support of these opinions.

It is sufficient in this report to outline the facts which seem definitely established, without disguising the gaps and the controversies which reduce the number of established facts, as well as reducing the value of many interesting observations.

It is, above all, important to set out clearly the practical consequences which proceed from the scientific data, and the directions in which such facts indicate, that prophylactic action should be carried.

The number of cholera carriers would appear to be very variable. They have been rarely met with amongst travellers from suspected regions which present themselves at the maritime or land frontiers of a country.

On the contrary, their discovery has been frequent when search has been made for them in the localities actually visited by an epidemic, and in the actual surroundings of the cholera patient.

It can then be stated that the number of cholera carriers is much less when the investigation is carried on outside of epidemic foci.

The relative abundance of vibrios in the faeces of carriers is not well defined. They are not, as a general rule, present in large quantities, but they can become increased to enormous proportions when the stools become diarrhœic.

Several cases are related of healthy carriers who have been attacked at a more or less late stage with definite cholera without having been exposed to a fresh infection. Are these cases frequent? Would healthy carriers be predisposed, as has been maintained, to become transformed into definite cases of cholera?

This question, which is important, has not yet been determined. It is not easy to distinguish carriers properly so called from persons whose evacuations conceal vibrios during the period of incubation of an attack of cholera.

The degree of virulence of vibrios given out by healthy carriers by those who are neither convalescents nor persons suffering from an abortive attack of cholera must vary considerably. It is believed that such vibrios are very attenuated in virulence. But there is no proof that cholera vibrios lose their virulence in the intestine of carriers, and this subject must at the present time be considered with great caution, the more so that the carrier in the best health may spontaneously become choleraic and that according to certain observers an untimely administration of a purgative is sufficient in such case to determine a definite clinical attack of cholera.

It has been found from a great number of examinations that the presence of vibrios in the stools of carriers is generally not very prolonged and rarely exceeds two to three weeks; nevertheless cases are recorded of carriers having continued to discharge vibrios during six months and even during a whole year.

Without desiring to detract from the significance, obtained by long and patient research, one must not, however, lose sight of certain other facts which must at times impose caution.

In the evacuations of carriers vibrios do not appear regularly or constantly. On the contrary, it does happen that they may be absent on several re-examinations of a carrier in whom they had been found. Period of intermission of 2, 3, 8, and 12 days have been reported. When re-examinations have not been made the liability to errors has been frequent.

It is important also to recognise certain errors of bacteriological technique, and in order to exactly appreciate the value of its results, it is necessary to bear in mind the difficulties and numerous errors which accompany it.

It has happened that vibrios which are highly agglutinable, having all the specific characteristics of the vibrios of Koch, have been met with in the persons of either sick or health individuals who have never been exposed, in all probability, to any cholera infection. Such vibrios have so far been found only in Egypt, and rarely there; but would they not be met with also in Europe itself in countries where cholera has not occurred for a long while?

In the present state of knowledge on the subject, a decision to consider such cases as cholera carriers would scarcely be justified, and less still would there be justification for restrictive measures against a country from which such persons came.

Moreover, in the stools of persons who have been in contact with cholera patients and who are justly suspected, there have been found vibrios of an atypical nature little or not at all agglutinable at the time of their isolation, and which have become agglutinable later. One must expect to meet frequently enough in healthy carriers two varieties of vibrios—one choleraic and the other of benign origin, the agglutinability of which varies from the lower scale to that considered the most specific.

Those non-agglutinable vibrios are very disturbing when a formal opinion as to the presence or otherwise of cholera has to be given. They are particularly troublesome for public health officials. In order to protect themselves the officials will consider such vibrios as indistinguishable from the cholera vibrios, and consequently Governments will sometimes be induced to take measures which are not justified.

There remains for consideration an estimate of the danger which carriers present as agents in the spread of cholera.

It was necessary for the Sub-Committee to estimate this danger from other points of view than the purely scientific. It is desirable to know precisely the extent of this danger and to consider it in relation to measures intended to overcome it, and in relation also the useful results which such measures can give.

Theoretically there is no difference of opinion as to the reality and extent of the danger; but there is a great diversity concerning the extent of the danger under actual practical conditions. Some declare themselves convinced that the danger is not great, and that it is almost negligible outside of epidemic foci.

Others maintain with the same conviction that the risk of transmission to a distance by the agency of carriers is very serious, and in any case is more considerable than has hitherto been supposed.

Certain authorities consider carriers are much more dangerous than known cases, for it is easy to recognise the latter and isolate them, whilst unrecognised carriers are at liberty to disseminate their infection.

Those who support the first of these opinions support their contention of the smallness of the danger by indicating the small numbers of vibrios given out, the low virulence of the organisms and their imprisonment in solid faecal matter. They make the most of the fact that the carriers are only more or less frequent in the entourage of the cholera patients where they can be detected without much trouble, and that they are very exceptionally met with on the frontiers of cholera-free countries.

They fortify their position by instancing the fact that countries such as Sweden, Greece, &c., have not been invaded by cholera in spite of their relationships with neighbouring countries seriously infected, which countries cannot have failed to supply carriers to them. And, finally, they call attention to the fact that there is no proved instance of the transport of cholera by carriers to any distance, and that all the known facts concerning the importation of this disease from country to country are in accord with the transmission by persons manifestly ill with cholera.

Those who support the opinion that the danger is a real and a grave one, see in certain recent epidemiological observations a demonstration of the important part played by carriers in the origin and disposal of local or regional epidemics, and even of the introduction of the disease into cholera-free countries. Amongst such observations, those presented by the delegates of Austria, of Roumania, and of Bulgaria, appear to us to be the most significant.

Between these two extreme opinions there may perhaps be a mean which does not lack supporters.

Carriers offer a certain amount of danger in respect of the extension of epidemics of cholera, and it cannot *a priori* be denied that they may be capable of introducing the disease into distant countries. But, as a matter of fact, there are no known facts establishing beyond question that cholera has been transported from an infected country to a free country by this means. In the present state of our knowledge it is difficult, and it would be imprudent, to define in any way precisely the extent of the risk of transmission of cholera by carriers from an infected district to a distant country.

In forming a practical estimate of the risks, no good would result, however, from exaggerating them, for in such case measures would necessarily be advised which would be excessive, out of proportion with the dangers they were intended to combat, and incapable by the defective guarantees which they would offer, of compensating for the immense prejudice caused to international relationships.

It cannot be doubted, in fact, that the search for carriers, applied systematically to large numbers of persons, applied generally at land or sea frontiers would, for its practical application, necessitate almost everywhere such enormous strain and colossal expenditure as would cause the majority of nations to decline to authorize it.

It is very certain also that it would produce very misleading results since it would not be necessary to limit the investigation to a single examination, or at the most two examinations, with a 24-hours interval in respect of each individual suspected, and deceit and fraud would soon render the results of the investigation absolutely problematical.

Organized on a vast scale along extended land or sea frontiers, the search for carriers, if the disorganization that it would create in international life was not in itself sufficient to render it totally impracticable, can only be as has been said—a deceit or a vain show.

It is important then to limit the search to persons suspected of being carriers to the situations when it can give assuredly profitable results, and where this measure corresponding to a well defined danger is found to be at the same time practically realizable.

The Sub-Committee has recognised unanimously that it has an undeniable usefulness as a part of the internal administration of a country, in order to check incipient or persistent epidemic foci, because there is always the probability that carriers will then be numerous, and because they may be discovered under such circumstances without disproportionate trouble.

The search for carriers appears to the Sub-Committee to be, on the other hand, a very uncertain measure, and impracticable if it be seriously desired to apply it to the whole of the passengers, to the crew of ships, and to each of the travellers arriving by a land route from an infected country. It appears to the Sub-Committee that the only occasions upon which such an investigation is indicated as an international measure are those of vessels (*a*) having cholera on board, or (*b*) having had cholera on board at a period of time less distant than the usual period of persistence of the vibrio in the presence of carriers. It is still more strongly indicated in the case of (*c*) travellers who have journeyed by a land route and who form the entourage of a cholera patient or of a person suffering from an illness suspected to be cholera. It is rational and legitimate to submit such persons, usually few in number, to a prophylactic measure which the regulations would apply to them in their own country in the same degree as they would apply to all other persons specially liable to contract cholera and liable to disseminate it around them.

The Sub-Committee has considered several propositions relating to other cases in respect of which the practical usefulness of the search for carriers deserves to be considered.

It would be the function of a competent Commission to determine these cases precisely, and to investigate as to the conditions under which such search for carriers could be authorized.

The Sub-Committee has also had to confine itself to placing on record the propositions of the delegates of Egypt, Austria, Portugal, Belgium, &c. They asked that it be permitted, as an exception, that search be made for carriers amongst the crew and certain groups of passengers upon ships coming from infected ports, when these ships had had a short voyage, even though there had been no case of cholera on board.

These ships could certainly introduce cholera carriers notwithstanding that the vessel appeared to be sanitarily satisfactory. Several members of the Sub-Committee are of opinion that the search for carriers under conditions carefully defined is practicable, and offers sufficient guarantee of effectiveness without entailing great disabilities upon international relationships.

The propositions which follow summarize the long discussions which the Sub-Committee has conducted, in order to determine the practical importance of the search for carriers from the point of view of national and international prophylaxis :—

> "In the present state of knowledge it is difficult to estimate the precise degree of danger which cholera carriers offer to the public health. On the one hand it is probable that they play an important rôle in the disposal of local epidemics; it even appears to be possible that they may sometimes be in such a condition as to transport living and virulent vibrios to a great distance.
>
> "On the other hand, no conclusive instance has been recorded of the transport of cholera to a great distance by cholera carriers, and many ascertained facts (the short duration of the presence of vibrios in the excreta, the usually limited number of vibrios, and the fact that they are enclosed in solid faecal material) are of such a nature as to justify the deduction that the influence of these carriers upon the origin and the progress of epidemic foci is exercised ordinarily over a limited area.
>
> "The search for carriers when it has to be conducted on large numbers of persons is attended sometimes with great difficulty. It is, moreover, rendered uncertain in the results by the fact that the emission of vibrios is often intermittent.
>
> "The search for carriers takes a place in the front rank of the prophylactic measures to be instituted in the interior of a country at the onset and during the course of the epidemic.
>
> "In international prophylaxis, as a general rule, it is not possible to take isolated carriers into consideration. But the search for carriers is technically indicated to the extent to which it may be realizable as a practical measure—
>
> (*a*) At sea frontiers in the case of having cholera on board, or having had cholera on board during the voyage.
>
> (*b*) At land frontiers in respect of travellers within the entourage of a cholera patient."

(7) The rôle which merchandise plays in the dissemination of cholera has long been settled.

The Conference of Dresden in 1893 has recognised that, with some rare exceptions, merchandise played no part in the spread of this disease. Recent information has not disturbed this view, to which the Sub-Committee subscribes without restriction.

Certain articles of food, however—such as fruit, milk foods, vegetables, as well as oysters, shellfish—have received attention, as these products have been convicted on occasions of having carried cholera vibrios to a greater or less distance.

The Sub-Committee has become aware of certain observations tending to show that these products have been dangerous. There is, however, no absolute proof that cholera has been conveyed to any distance, from one country to another, by their agency.

For international commerce there is no justification for attaching any importance to the risks of exportation of cholera vibrios by fruits, vegetables, cheese, shellfish, &c.

But in traffic across frontiers they can undoubtedly offer a more or less limited danger by reason of the short period of time between their contamination at the point of departure and their consumption in a cholera-free country. This danger should be provided against by special arrangements between Governments of adjacent countries.

The Sub-Committee believes that it can affirm afresh that articles of food may not be considered or treated as articles especially liable to convey cholera vibrios, any more than other articles of merchandise. They are a danger only to the same degree as any other articles whatever exposed to contamination with cholera infection.

The two above propositions have been formulated as follow :—

> There is no recorded instance of the transport of cholera to a great distance by the agency of merchandise (including articles of food) having been established with certainty. But all objects soiled by cholera excretions can be the origin of new infections so long as the vibrios remain alive. The articles to be especially regarded with suspicion are body linen, bedding, wearing apparel, and articles for personal use. Foodstuffs, moreover, can play a part in the spread of cholera in the neighbourhood of the cholera patient.

(8) Water for human consumption carried by ships is generally pumped overboard on arrival in port. It is well known how careless captains are generally about obtaining their water from a reliable source. Sometimes they have obtained their water from a public water supply in which the existence of cholera vibrios had been determined.

Nevertheless there is no case on record of an epidemic having been originated by organisms introduced into a port with the drinking water of a ship. Although the possibility of the transport of cholera vibrios over a great distance by this means may not be doubted, yet the danger of the evacuation of this water into the waters of a port would appear to be very small.

The Paris Convention confined itself to recommending that water of good quality be substituted for the water on board of vessels coming from an infected country.

The disinfection of drinking water before its discharge into the waters of a port is advisable.

The Sub-Committee has recognised the danger from drinking water on board ship in the following proposition :—

> Water taken on board vessels as drinking water should be the object of special precautions, especially when it has been taken on in an infected port.

(9) Water ballast.

Water ballast, of which modern ships carry enormous quantities, is taken on the spot from docks and roadsteads, and is discharged in greater or less quantities in the port of destination at the time of unloading.

It is not rarely that water ballast remains stored on board for several weeks; waters from the Hoogli, which have washed the docks of Calcutta, are in this way often carried from the permanent focus of cholera to European ports.

The possibility of the importation of cholera vibrios by water ballast depends upon the condition of the water in the ports where it was obtained. Water ballast generally contained in inaccesible tanks is not exposed to contamination by cholera excreta when this disease breaks out on board. It may be dangerous upon a healthy ship and not in any way contaminated on a ship on which cholera is present.

The available data on the subject of the circumstances which favour or hinder the persistence of cholera vibrios in sea water, in brackish, or in fresh water, which is used as ballast, are inconclusive, and do not agree amongst themselves. It is constantly demonstrated, particularly by experiments recently made at Copenhagen, that these organisms may, under certain circumstances, remain alive during several weeks in water which has a very high chlorine content.

No facts are known which prove beyond doubt that water ballast has imported cholera into a healthy port.

In spite of any conditions which may render the survival of the vibrios in water ballast and in the water of a port into which it is discharged very precarious, it is reasonable and advisable to treat water as if it were contaminated on each occasion when it has been obtained from a suspected source.

Vessels should only be permitted to discharge such water at an adequate distance from any port. In deep water ports communicating directly with the open sea, the discharge of water ballast may take place without running serious risk.

When disinfection of water ballast is practicable, it should be required. Unfortunately this operation is always laborious, and often long and troublesome. Moreover, it is of very doubtful efficacy.

Disinfection could be effected under much more satisfactory conditions if the arrangement of the tanks upon modern ships was slightly modified. It is for the designers to study suitable modifications which would save the owners considerable expense. Possibly also the sanitary authorities in the contaminated ports might take the precaution of placing in the tanks before filling a sufficient amount of disinfectant material. Favorable treatment should be accorded to vessels so treated.

Until such a practice becomes general the sealing of the tanks, whether empty or full, on arrival of the vessels, is the most practicable method of procedure.

The dangers from water ballast having been admitted by the Sub-Committee, the following proposition has been adopted as expressing this principle :—

> Water taken on as water ballast and emptied into healthy ports may be suspected of spreading cholera infection when it comes from contaminated ports.

Bilge waters which come from infiltrations through badly fitting joints on wooden ships, mixed with waste water which is often contaminated with rubbish, and often with excreta from the crew, may be dangerous when there have been cases of cholera on board, or when the ship has called at infected ports.

Such water collects in much less quantities on the large modern iron ships, for in such cases this water is water of condensation from the walls of the vessel, and they are less exposed to serious contamination. They may, however, become infected when there are carriers amongst the engine-room crew or amongst the stevedores who stowed the cargo, or when the water for use in the engines has been taken on at an infected anchorage.

The disinfection of bilge water before its discharge is advisable. The Convention of 1903 prescribes it for vessels "infects" or "suspects." It should be prescribed for each occasion on which the vessel has stayed in any port, dock, or roadstead from which it might receive cholera excreta.

The Sub-Committee has thought that it should confine itself to pointing out the danger from bilge water and water ballast coming from infected ports. It recognises that it is difficult to estimate this danger, which is doubtless relative, and may be very small in many cases; but it should not be ignored amongst the various means of importation of cholera vibrios to which navigation is exposed.

In order to combat this danger no measure appears to be exclusively indicated, although disinfection is theoretically the only natural measure.

But since such disinfection would appear to be far from being easily practicable, the Sub-Committee has thought that there are good grounds for insisting as a more satisfactory preventive measure, that the water of docks and roadsteads, and accordingly the water ballast drawn therefrom, should be protected from contamination.

The Sub-Committee has recorded the resolution that the future Convention should urge the recommendation that seaport towns should be rendered sanitary. They should all be provided with a public water supply, and thereby avoid the necessity for use of the contaminated water of their docks and roadsteads.

In the discussion which followed this report it was first moved* (by Professor Gaffky, of the German delegation) that the necessity of making provision for the search for carriers be included as follows :—

> Every public health official finding himself confronted with a suspected case of cholera on a vessel should have the right of conducting all such methods of bacteriological research as are necessary to complete his diagnosis.

This, however, was not adopted by the Commission, but while the Commission would not commit itself quite so completely, it fully recognised the principle of the search for carriers by amending the text of the articles of the Paris Convention of 1903 relating to cholera by the addition of the following clause (Article 27) :—

> Provided that this period (*i.e.*, five days) be not exceeded, the sanitary authority may proceed to bacteriological examination so far as is necessary.

The above represents the only important amendment on the Paris Convention of 1903.

The same principle is further recognised in Article 35, which reads as follows :—

> Special measures may be prescribed as regards ships that are in an insanitary condition or overcrowded, especially bacteriological examination in the case of cholera.

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* Procés Verbaux, p. 871.

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